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ABSTRACT

This guide serves as a resource for performance-based learning experiences designed to assist secondary school home economics students in developing competencies essential for effective energy use and management. A rationale for performance-based vocational education; definitions/explanations of the terms "competency," "performance-objective," "performance-guide," and "learning experiences"; diagram illustrating relationships of the components indicated in the terms; list of 10 energy education competencies; and an outline of a conceptual structure of energy education are provided in an introduction. The first section provides, in chart format, performance objectives, performance guides, learning experiences, and instructional resources related to each competency. The second section provides supplementary materials referred to under the instructional resources columns in the first section. Materials include various types of activities, readings, worksheets, and overhead transparency masters. A 27-item bibliography, annotated media listing, and evaluation form are also provided. (JN)

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SE 038 785

A GUIDE FOR PLANNING PERFORMANCE — BASED ENERGY EDUCATION IN HOME ECONOMICS EDUCATION PROGRAMS

Home Economics Education
Program Planning and Development Section
Office of Vocational Education

July, 1982

SOUTH CAROLINA DEPARTMENT OF EDUCATION

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FORWORD

Home Economics Education is the field of knowledge and service primarily concerned with strengthening individual and family well being. Home economics recognizes the need for student competence in dealing with daily situations. Educators in this field hope to develop socially sensitive individuals who understand the relationship between their roles and society; who can appreciate and enjoy a variety of creative expressions; and who are able to examine their beliefs and values and reflect this examination in changed attitudes and behavior. Concentrated efforts are made to develop the desire and ability for effective decision making in the feeding of, clothing of, sheltering of, providing security for, and interaction within the family. All endeavors are directed toward helping the student live more effectively in his/her community and nation as a citizen, family member, and employed person.

Within this framework, energy education should be an integral part of the secondary Home Economics Education program. Students well-informed about energy management, energy alternatives, and energy conservation are imperative to our society's future well-being.

The information contained in this guide is designed to be infused in a number of home economics education courses. The guide can serve as a resource for performance-based learning experiences designed to assist students develop competencies which are essential for effective energy use and management.

The Home Economics Education staff expresses sincere appreciation to Dr. Betty L. Stout, Assistant Professor, School of Consumer Science and Allied Professions, Winthrop College and Mary Etta Livingston, Curriculum Designer, Curriculum Development Section, Office of Vocational Education, for the time, talent, knowledge, skill and enthusiasm devoted to the completion of this Energy Education Guide. Gratitude is also expressed to those teachers throughout the state who used the material and provided valuable constructive information.

Dr. Brenda C. Compton, State Supervisor
Home Economics Education

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INTRODUCTION

South Carolina is involved in a major effort to implement performance-based vocational education. PBVE focuses on providing each student with the specific skills and knowledge required to obtain and hold a job in the field of his/her choice. Performance-based vocational education relies on these assumptions:

1. The skills and knowledges that students learn should be directly related to the duties and responsibilities they will have to perform on the job.

2. These skills and areas of knowledge, and the means for evaluating their attainment, should be specified in advance and made known to the students.

3. Students should be provided with whatever instructional experiences they need to attain the skills and knowledge required by the jobs they are aiming for.

In performance-based education, the emphasis is on attaining clear-cut, measurable, competencies - not on spending two years in a course, getting a passing grade, or any of the other conventional standards for evaluating a student's progress. Since performance-based vocational education stresses helping every student acquire the specific skills and knowledge needed on the job, the student outcomes, or competencies desired, must be clearly defined.

Consumer management is a "job" involved in the occupation of homemaking. All individuals, male and female, are homemakers. A Guide for Performance-Based Energy Education in Home Economics Programs has been developed to assist the home economics teacher in designing a performance-based instructional program to prepare students for the occupation of homemaking. The guide identifies competencies necessary for effective functioning within a complex economic system. Performance objectives, essential to any PBVE program, have been written to identify specific behaviors and/or skills the student must demonstrate in relation to the overall competencies needed. Performance guides have been utilized to indicate a series of steps which, when completed, should enable the student to perform the task/behavior specified by the performance objective.

Each teacher is encouraged to use this guide as a beginning foundation for the development of performance-based instruction within the home economics program. As this guide is used and such instruction is developed, it is necessary to understand the basic terms and premises involved.

Competency

A skill, either cognitive, affective, or psychomotor, which is required in life or in a vocation and which the student is expected to master and demonstrate at the completion of the educational program.

Performance-Objective

A statement which gives direction to learning by communicating the intent or purpose of the learning--a statement of what the learner is to be able to do when he/she has successfully completed a learning experience.

In developing a course of instruction, performance objectives can be used in at least four major ways. First, stated objectives can help identify exactly what should be taught and force teachers to make decisions which should clearly define the goals of instruction.

Second, objectives aid in sequencing content within the course, and helps the teacher select appropriate instructional techniques and materials. Third, stated objectives simplify the development of those measures that will determine the student's ability to perform tasks. The criteria for making judgements about the performance levels of students is determined prior to actual instruction. Finally, after a program (or course) has been developed and used in the classroom, the objectives provide a means of evaluating the success of that program.

A performance objective must contain the following:

1. Identification of the terminal performance which the teacher attempts to produce. (Terminal performance refers to the behavior the student is to be able to demonstrate at the conclusion of a learning experience.)

2. Description of the important conditions under which the behavior is expected to occur. (Conditions refer to any and all limits or circumstances under which the student will perform.)

3. Identification of a standard, criteria, or level of acceptance. (Level of acceptance refers to how well the student must perform the task/behavior in order to be classified as having achieved mastery.)

Performance-Guide (PG)

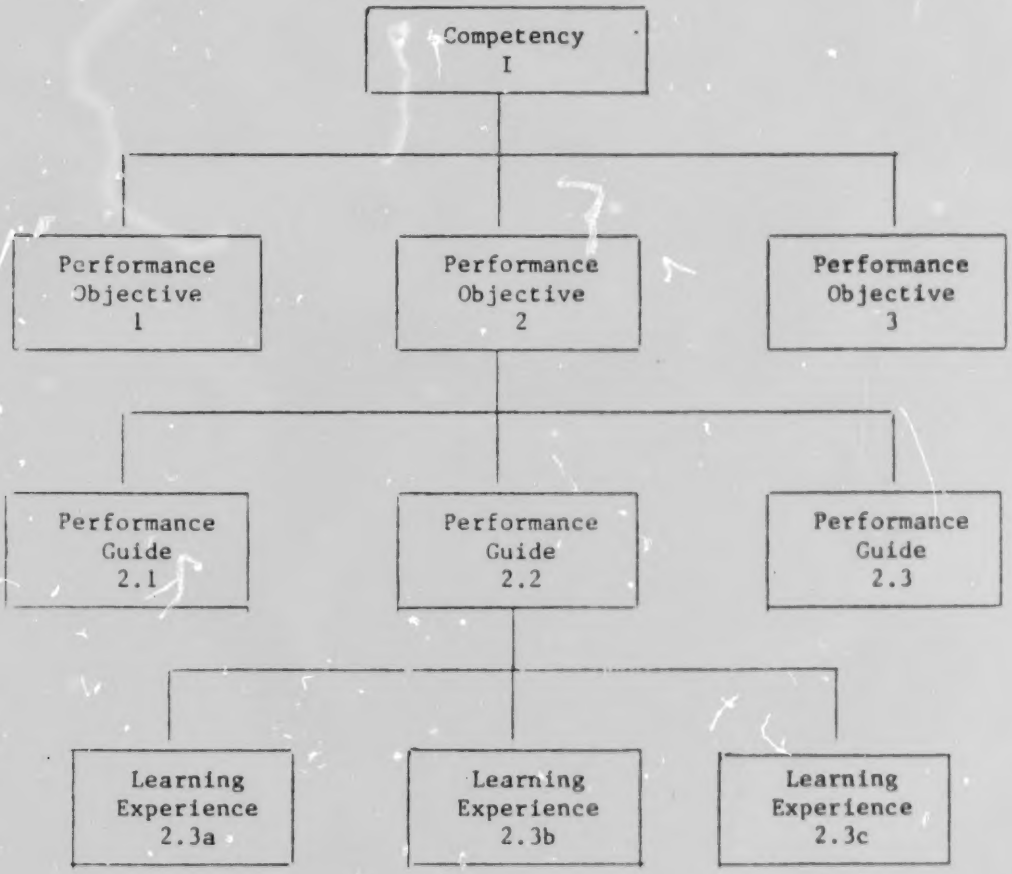
A series of steps arranged in a sequence ordinarily followed which, when completed, may result in the performance of a task.

The guides may be viewed as enabling objectives which help the student work toward achievement of the performance objective.

Learning Experiences

A series of activities designed to assist the student master specific knowledge and skills. Because PBVE is student centered, all learning experiences are written in terms of what the student should do. Student learning experiences dictate the teacher preparation and teacher activities which are necessary.

The diagram below indicates the relationships of the components of the guide. Note that performance guides and learning experiences are pictured for only one objective. It must be remembered that each objective has its respective guides and experiences.



To facilitate the use of the guide, two symbols have been used to denote teacher evaluation activities.

e - Designates evaluation related to a performance guide (or enabling objective). When this symbol is used after a learning experience, it is suggested that the teacher evaluate the student's work and inform the student of his/her progress toward achievement of specific tasks.

E - Designate evaluation related to a performance objective. When this symbol appears after the learning experiences, it indicates that the student has completed activities contributing to the achievement of each performance guide and is now ready to demonstrate mastery of a major task. Successful completion of the performance objective indicates the student possesses a skill which contributes to the achievement/mastery of the competencies of the educational program.

The Guide for Performance-Based Energy Education in Home Economics Programs has been designed to promote an effective PBVE program. It is hoped that teachers will use this resource to expand performance-based instruction within Home Economics Education.

ENERGY EDUCATION

Competencies

EE-1. The student will understand how evolving technology has increased the availability of energy consuming equipment and appliances which permit comfort, convenience, security (safety), pleasure, recreation, and beauty.

EE-2. The students will understand basic principles of energy and facts about energy sources and will be able to relate these principles and facts to energy decisions.

EE-3. The student will recognize indicators of an individual's energy use lifestyle and will understand that a quality lifestyle is dependent upon choices among alternatives which benefit the family unit.

EE-4. The student will understand the consumer energy situation using a systems approach.

EE-5. The student will understand how the decision-making process regarding the purchase of major appliances in enhanced with the knowledge of the long-range cost of energy consumed by the appliance.

EE-6. The student will recognize the role of natural environment in relation to siting, orientation, landscaping and design of housing for energy conservation.

EE-7. The student will use knowledge of the natural environment in selection of the site, orientation, landscaping and design of housing for energy conservation.

EE-8. The student will understand the relationship between the control of air infiltration/exfiltration and heat conduction to material and methods used to control heat transfer.

EE-9. The student will classify various aspects of the active solar system, relate active solar system to house design and predict the possible lifestyle changes neccessitated by solar heating.

EE-10. The student will understand the energy options available and describe the feasibility of the options for future use.

UNIT: Energy Education

COMPETENCY: EE-1. The student will understand how evolving technology has increased the availability of energy consuming equipment and appliances which permit comfort, convenience, security (safety), pleasure, recreation, and beauty.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
1. When asked, the student will identify the three problems of providing useful energy forms: i.e., extraction, conversion, conservation.	1.1 Define the term "technology".
	1.2 List energy sources and recognize the order in which they come into use in the United States.
	1.3 Identify the problems of making energy forms which are useful: extraction, conversion, conservation.
	1.4 Name possible future energy sources and identify how technology will be affected by these new sources.

LEARNING EXPERIENCES		INSTRUCTIONAL RESOURCES
1.1a.	Use dictionary resources to develop a definition of ''technology''. Relate to the technology education program in your school, if possible.	
1.1b.	Discuss our dependence upon technology.	
1.1c.	Discuss how technology has affected consumers' lives throughout history.	
1.1d.	List technological accomplishments which have helped families conserve energy.	
1.2a.	View film. Draw a time line and record energy sources along the line while watching film to indicate when sources were first used in the United States.	Film: ''Energy: The American Experience Appendix: Supplement 1A., ''Time Line''
1.2b.	Research and identify at least two ways in which man immediately used each source. e	
1.3a.	Review film to answer the question: ''What are problems of making energy forms which are useful?'' Consider cost, efficiency, availability of resources, and technology when forming your answer.	
1.3b.	Discuss examples from the film which show that questions related to energy i.e., how to extract, convert and conserve energy, have been the same throughout history but the solutions are different.	
1.4a.	Read ''Energy: The American Perspective''.	Appendix: Supplement 1B; ''Energy: The American Perspective.''

UNIT: Energy Education

COMPETENCY: EE-1. The student will understand how evolving technology has increased the availability of energy consuming equipment and appliances which permit comfort, convenience, security (safety), pleasure, recreation, and beauty.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
2. Given a listing of the contributions of energy, the student will be able to list two examples of energy consuming equipment and/or appliances which exemplify each contribution on the list.	2.1 Name the functions energy serves.
	2.2 Identify personal use of appliances.
	2.3 Describe the growth in use of electrical appliances in the United States.
	2.4 List the positive and negative aspects of energy resource use.

LEARNING EXPERIENCES		INSTRUCTIONAL RESOURCES
1.4b.	Summarize the future energy sources presented in the film and in the handout in activity 1.4a.	
1.4c.	Discuss how technology might be affected by the new energy sources.	
E	Identify 3 problems involved in providing useful forms of energy.	
2.1a.	Discuss what energy has done for us. Examples: Saves time, entertainment, safety, esteem, beauty, comfort, convenience.	
2.1b.	Round robin to identify equipment/ appliances which provide these conveniences/pleasures.	
2.2a.	Check the appliances you have used in your home, school, church on the worksheet. Using the space provided on the worksheet, write in what each appliance does for the consumer.	Appendix: Supplement 2; ''Appliance List''
2.2b.	Categorize the listing according to useage. Examples: Personal hygiene, food preparation, home maintenance/management, entertainment.	
	e	
2.3a.	Survey parents, people your grandparents age and/or other adults in the community to determine which appliances were used 25 years ago and 50 years ago.	
2.3b.	Compile class findings into one list; discuss how advancements have changed consumers lives.	
2.4a.	Use the appliance list to identify 6 commonly used appliances. List a positive and a negative use of each.	

UNIT: Energy Education

COMPETENCY: EE-1 The student will understand how evolving technology has increased the availability of energy consuming equipment and appliances which permit comfort, convenience, security (safety), pleasure, recreation, and beauty.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
	2.5 Give examples of historical change in the focus of energy conservation from one of conserving human energy to the need to conserve mechanical energy.

LEARNING EXPERIENCES	INSTRUCTIONAL RESOURCES
2.4b. Select 3 of these appliances and suggest ways of combating the negative use identified. e 2.5a. Discuss the difficulties in focusing on conservation of human vs. conservation of mechanical energy. Relate to the appliance listing, used in activity 2.2a, emphasizing ways machines do tasks formerly done by people. 2.5b. Form buzz groups to share all the mechanical and human forms of energy used from 7:00 am to noon on a specified day. F List two examples of energy consuming equipment and/or appliances which exemplify the contributions of energy.	

UNIT: Energy Education

COMPETENCY: EE-2. The students will understand basic principles of energy and facts about energy sources and will be able to relate these principles and facts to energy decisions.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
1. Students will respond, with 90% accuracy, to teacher-made test on sources, laws, properties of energy.	1.1 Identify the forms of energy.
	1.2 Identify the laws governing the use of energy.
	1.3 Identify the primary energy sources, their availability, and their end uses.

LEARNING EXPERIENCES		INSTRUCTIONAL RESOURCES
1.1a.	Respond to questions asked by teacher. Summarize the number of incorrect answers or no responses received for the questions.	Appendix: Supplement 3; ''Energy Awareness''
1.1b.	Review worksheet, ''Energy Facts'', for overview of facts to be obtained from readings.	Appendix: Supplement 4; Worksheet, ''Energy Facts''
1.1c.	Read handout, ''Energy: What It Is, What It Does'' to define kinetic and potential energy. Give examples of energy in kinetic energy in the classroom (heat, light, and motion).	Appendix: Supplement 5; ''Energy: What It Is, What It Does''
1.2a.	From information in Supplement 5, define the First and Second Laws of Thermodynamics.	
1.2b.	Complete question No. 1 on worksheet, ''Energy Facts'', reviewed in activity 1.1b.	
1.2c.	Discuss the influence that knowledge of the laws of thermodynamics should have on each consumer.	
1.2d.	Locate application of the ''Second Law of Thermodynamics'' within the classroom. Example: Lights giving off heat.	
1.3a.	Read ''Where Does the Energy We Use Come From?''	Appendix: Supplement 6; ''Where Does The Energy We Use Come From?''
1.3b.	Complete question No. 2 in the worksheet, ''Energy Facts''.	

UNIT: Energy Education

COMPETENCY: EE-2. The student will understand basic principles of energy and facts about energy sources and will be able to relate these principles and facts to energy decisions.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
	1.4 Recognize examples of the conversion of energy and the relationship to the laws of thermodynamics
	1.5 Recognize the end use of energy.

	LEARNING EXPERIENCES	INSTRUCTIONAL RESOURCES
1.3c.	Divide into groups and set up role play situation as follows: ''Assume you are speaking at a world conference on 'Our Energy Future'. Each group select a primary energy source from hand-out, 'Where Does the Energy We Use Come From?'. Convince the class of the importance of your source in meeting energy problems''.	Appendix: Supplement 6; ''Where Does the Energy We Use Come From?''
1.3d.	Discuss what knowledge of availability of energy sources should mean to consumers.	Appendix: Supplement 6; ''Where Does the Energy We Use Come From?''
1.4a.	Read ''The Flow of Energy''. Locate primary, intermediate and end uses of energy on diagram.	Appendix: Supplement 7; ''The Flow of Energy::
1.4b.	View film ''Endless Chain''.	Film: ''The Endless Chain''
1.4c.	Using handout, ''Energy Conversions'', trace energy consumption activities to their primary energy source.	Appendix: Supplement 8; ''Energy Conversions''
1.4d.	Look within the classroom for examples of energy conversions.	
1.4e.	Complete questions No. 3 on worksheet, ''Energy Facts''.	
	e	
1.5a	Role play teaching the end used of energy to a first grade class.	
1.5b.	Illustrate the phrase ''We Know Energy by What It Does'' by looking at transparencies of heat, light, and motion from a child's coloring book.	Appendix: Supplement 9; ''We Know Energy by What It Does Overhead projector
E	Complete test on sources, laws, proof of energy.	

UNIT: Energy Education

COMPETENCY: EE-2. The students will understand basic principles of energy and facts about energy sources and will be able to relate these principles and facts to energy decisions.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
2. The student will describe three reasons to conserve energy, basing their answer on knowledge of source, laws, and properties of energy.	2.1 Identify energy consumption patterns in America.
	2.2 Identify three reasons to conserve energy.

LEARNING EXPERIENCES	INSTRUCTIONAL RESOURCES
2.1a. View diagram of energy use and source patterns from 1970–2000.	Appendix: Supplement 10; ''Energy Consumption Patterns in America''
2.1b. Form buzz groups to discuss this question: ''Given knowledge of the availability of energy sources and the present consumption pattern, what are the alternatives we have as consumers?''	
2.1c. Complete question No. 4 on worksheet, ''Energy Facts.''	
2.2a. Discuss the idea that conservation is our most readily available energy source.	
2.2b. Read ''How Much Energy Can be Conserved by Recycling?''.	Appendix: Supplement 11; ''How Much Energy Can be Conserved by Recycling?''
2.2c. Make a listing of reasons for conserving energy. Write ideas on transparency or board. Look for categories of responses such as: 1) Protects the environment 2) Saves resources 3) Saves money	
2.2d. Complete question No. 5 on worksheet; ''Energy Facts''.	
e	
2.2e. Design a bulletin board illustrating the importance of conservation of energy or some aspect of this lesson on the physical properties of energy.	Bulletin board.
E Describe in writing, 3 reasons to conserve energy. Base answer on knowledge of sources, laws and properties of energy.	

UNIT: Energy Education

COMPETENCY: EE-3. The student will recognize indicators of an individual's energy use lifestyle and will understand that a quality lifestyle is dependent upon choices among alternatives which benefit the family unit.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
1. After completing a lifestyle index the student will be able to identif, with 90% accuracy the indicators of energy consumption on a teacher-made test.	1.1 Define lifestyle.
	1.2 Classify known lifestyles as ''simple'', ''conservative'', or ''extravagent'' in relation to energy use.
	1.3 Identify personal and family energy usuage based on a lifestyle index.

	LEARNING EXPERIENCES	INSTRUCTIONAL RESOURCES
1.1a.	Participate in energy use activity explained by teacher.	Appendix: Supplement 12; ''Energy Consumption Continuum''
1.1b.	Use dictionary to define lifestyle. Suggest ideas about how and why the things people do are related to their characteristic lifestyle.	
1.2a.	Define terminology: simple, conservative, extravagent lifestyle.	
1.2b.	Suggest popular families from television shows, newspapers, or cartoons which you consider to represent simple, conservative, or extravagent lifestyles. Place each family on a continuum from simple to extravagent.	Appendix: Supplement 13; ''Family Lifestyle Discussion Guide''
1.2c.	Collect samples of objects used in countries with less complex lifestyles and compare with comparable items used in the United States to accomplish the same task. (An example would be a hand fan versus an electric fan.)	Missionaries can be a source of information for this learning experience.
1.3a.	Complete ''Lifestyle Index'' as a homework assignment.	Appendix: Supplement 14; ''Lifestyle Index''
	e	
1.3b.	Compare total annual expenditures of energy with that of the average U.S. citizen and with those of citizens of other countries using the charts at the end of the lifestyle index.	
1.3c.	Discuss ways you can conserve energy. List energy use patterns which are identified as beyond the control of the consumer in the Lifestyle Index.	
E	Identify indicators of energy consumption on a teacher made test.	

UNIT: Energy Education

COMPETENCY: EE-3. The student will recognize indicators of an individual's energy use lifestyle and will understand that a quality lifestyle is dependent upon choices among alternatives which benefit the family unit.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
2. After a description of alternative responses to the energy shortage, the student will be able to name four alternative choices in meeting an energy need and describe how each affects daily life.	2.1 Distinguish between the following responses to the energy shortage and give examples of each: a. ignoring the energy situation b. using alternative sources c. curtailment d. conservation 2.2 Describe how both curtailment of energy and conservation of energy would affect lifestyles.

LEARNING EXPERIENCES		INSTRUCTIONAL RESOURCES
2.1a.	Debate the validity of the enrgy crisis. Students may need to read sources denying the energy crisis to prepare for the debate.	
2.1b.	Brainstorm as a group: ''Alternative responses to the energy crisis.''	
2.1c.	Form buzz groups to identify the sources other than oil or gas that might supply communities with needed energy. Write responses on sheet of paper. Hold written reactions until the last lesson in this guide is taught.	
2.1d.	Students read ''Definitions of Conservation and Curtailment'' to differentiate between curtailment and conservation.	Appendix: Supplement 15. ''Definitions of Conservation and Curtailment''
2.2a.	Students write a description of the changes in their lives necessary in a day without electricity.	
2.2b.	Refer to handout ''Definition of Conservation and Curtailment'' again.	Appendix: Supplement 15. ''Definition of Conservation and Curtailment''
2.2c.	List four reasons conservation is a long-term necessity.	
E	Describe four alternative choices in meeting an energy need. Describe how each affects daily life.	

UNIT: Energy Education

COMPETENCY: EE-3. The student will recognize indicators of an individual's energy use lifestyle and will understand that a quality lifestyle is dependent upon choices among alternatives which benefit the family unit.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
3. After reviewing the four methods of conserving energy the student will list one practical activity he/she can do to demonstrate each method.	3.1 Define direct and indirect calculation in the use of energy sources.
	3.2 Name ways human energy can be substituted for non-human or mechanical sources.
	3.3 Identify energy conservation methods which necessitate a change in lifestyle and those which do not imply a lifestyle change.

LEARNING EXPERIENCES	INSTRUCTIONAL RESOURCES
3.1a. Examine an electric bill and identify the amound of direct energy consumed in using appliance and equipment. Refer to the lifestyle index to calculate indirect energy use.	Electric Bill Appendix: Supplement 14; ''Lifestyle Index''
3.1b. View transparacies. Discuss how using energy closest to its source decreases energy loss.	Appendix: Supplement 16 & 17; Transparencies ''Stepping Off Energy'' and ''Discover Your Energy Identity'' Overhead projector Note to teacher: The information contained in transparencies can be used to develop a flannel board presentation.
3.2a. List five tasks which can be accomplished using an electrical appliance. Write or suggest a non-electrical alternative for accomplishing the same tasks. Which alternatives would require a change in lifestyle? e	
3.2b. Discuss the idea that as the need for non-human energy sources decreases the need for human resources increases. Keep in mind the examples of human energy sources (time, knowledge, skills, work capacity, mental ability) and non-human examples (money, appliances, car, home).	
3.3a. Survey persons 70 years or older to determine how household tasks were done when they were younger (cooking, acquiring food, heating the home, travel).	

UNIT: Energy Education

COMPETENCY: EE-3. The student will recognize indicators of an individual's energy use lifestyle and will understand that a quality lifestyle is dependent upon choices among alternatives which benefit the family unit.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
	3.4 Recognize energy management (attaining greater efficiency) as a conservation method.

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LEARNING EXPERIENCES		INSTRUCTIONAL RESOURCES
3.3b.	Read handout, ''An Energy Conservation Ethic''.	Appendix: Supplement 18A. ''An Energy Conservation Ethic'' Recommended reading: J. C. Penny. Forum: People, Progress and Priorities. Fall/Winter, 1976.
3.3c.	Complete activity sheet, ''An Energy Ethic''.	Appendix: Supplement 18B; ''An Energy Ethic''
3.3d.	Read handout, ''Voluntary Simplicity of Lifestyle, Shaping the Future''.	Appendix: Supplement 19; ''Voluntary Simplicity of Lifestyle''
3.3e.	React to ''going back to nature and living more independent lives'' as a response to the energy shortage. e	
3.4a.	Discuss the idea that management is taking what you have to get what you want. List ways to do an energy consuming task more efficiently such as using florescent rather than incandescent lighting and using lower horsepower motors.	
3.4b.	Complete activity sheet, ''Residential Energy Checklist''.	
3.4c	Using any listing of energy conservation ideas, check off conservation techniques you would be willing to practive within the the next week or month.	Appendix: Supplement 20; ''Residential Energy Checklist'' ''Tips for Energy Savers'' Available from: USDOE Technical Information Center P. O. Box 62 Oak Ridge, Tennessee 37830 (Free)
E	Name one practical activity to demonstrate each of the following four methods of meeting energy needs: a. direct vs. indirect use b. human vs. mechanical sources c. lifestyle alterations d. management	

UNIT: Energy Education

COMPETENCY: EE-4. The student will understand the consumer energy situation using a systems approach.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
1. The student will identify six systems interacting with the family which have the greatest influence on a particular energy situation.	1.1 Define the terms ''system'' and ''interaction'' as the terms relate to a systems approach for the study of energy.
	1.2 Identify systems interacting with the family which influence energy decisions.
	1.3 Differentiate between aspects of energy use over which the consummer has control and those over which the consumer has little or no control.

LEARNING EXPERIENCES		INSTRUCTIONAL RESOURCES
1.1a.	Compare the energy situation to a puzzle to which there is no simple solution. A ''brain teaser'' type of puzzle can be used to illustrate the analogy with the lack of a simple solution to the energy problem.	Any puzzle
1.1b.	View transparency, ''Systems Approach to Consumer Energy Use'', and read handout, ''Systems Defined and Explained''.	Appendix: Supplement 21; ''Systems Approach to Consumer Energy Use'' Overhead projector Appendix: Supplement 22A; ''Systems Defined and Explained''
1.2a.	Discuss how systems affect family decisions.	Appendix: Supplement 22B; ''Systems Influencing Families''
1.2b.	Observe your family for one week. Associate each of the following systems with an energy decision: a. physical b. economic c. government d. social-cultural e. technological f. world	
1.2c.	Collect and share newspaper and magazine articles about energy use which are examples of influences on consumer decisions.	Appendix: Supplement 23 A, B, & C Clippings from newspapers, books, and magazines.
	e	
1.3a.	React to the following statement: ''Over one half of the family's energy needs are determined by factors beyond the control of the family.''	

UNIT: Energy Education

COMPETENCY: EE-4. The student will understand the consumer energy situation using a systems approach.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
	2.1 Define the terms; 1) watt, 2) kilowatt 3) kilowatt-hour 2.2 Calculate the average annual wattage and operating costs of an electric bulb. 2.3 Read an electric meter.

	LEARNING EXPERIENCES	INSTRUCTIONAL RESOURCES
1.3b.	List examples of how the consumer can influence energy use. (Example: Consumer influence on legislation through voting power and consumer demand for solar equipment for existing homes.)	
E	Explain in writing the relationship of understanding the systems approach to implementing energy management. Examples: Technology, societal norms, economics, available resources in the environment, world affairs and government action contribute to an individual's consumption pattern.	
2.1a.	Look for definitions of watt, kilowatt, and kilowatt-hour in the dictionary.	
2.2a.	Work problem on transparency.	Appendix: Supplement 24; ''Porch Light'' Transparency Overhead projector
2.3a.	Read handout on monitoring an electric meter. Complete the sample problems.	Appendix: Supplement 25; ''Meter Reading''
2.3b.	Bring electric and/or gas bills (with parent's permission) to class. Make a comparison between current and old energy cost if parents or teacher have energy bills that are several years old.	Sample utility bills
E	Complete activity on other handout ''Thermostat Setback'' or ''Hot Water Audit''	Appendix: Supplement 26A & B; ''Thermostat Setback'', ''Hot Water Audit''

UNIT: Energy Education

COMPETENCY: EE–4. The student will understand the consumer energy situation using a systems approach.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
	3.1 Identify the major household users of energy.
	3.2 Apply energy-use information to energy decisions over which the consumer has control.
	3.3 Identify the purpose for load management.

LEARNING EXPERIENCES		INSTRUCTIONAL RESOURCES
3.1a.	Relate the proportion of energy used in the home to the total energy consumption in the United States.	Appendix: Supplement 27; ''Energy Use in the United States'' transparency Overhead projector
3.1b.	Examine several appliances to determine lable information such as watts, volts. Compare wattage on appliances in the classroom (such as a blender, refrigerator, or microwave oven) to the wattage given on the Energy Data Sheet.	Appendix: Supplement 28; ''Annual Energy Requirements of Electric Household Appliances Under Normal Use''
3.1c.	Complete the problems on the handout, ''Energy Consumption of Appliances'', to determine the energy consumption of home appliances and equipment.	Appendix: Supplement 29; ''Energy Consumption of Appliances''
e 3.2a.	Rank order energy use activities from the most to the least energy usage.	Appendix: Supplement 30; ''Residential Energy Use''
3.3a.	Listen to an explanation of load control.	Appendix: Supplement 31A; ''Residential Electric Service Charge''
3.3b.	Read about the winter and summer peak periods. Think of tasks which can be done in ''off peak'' hours.	Note: Content will need to be updated by the teachers as this curriculum guide ages.
3.3c.	Read handout, ''Electricity Rates of the Future Analyzed''. List four of the seven proposed rate designs and explain the advantages to the consumer of the four rate designs listed.	Supplement 31B, ''Electric Rates of the Future Analyzed''
E	Plan a homemakers tasks for five days to show that ''load control'' is a managable consevation option. (Half of the class plan for a full-time homemaker, the other half for a dual-role homemaker).	

UNIT: Energy Education

COMPETENCY: EE-5. The student will understand how the decision-making process regarding the purchase of major appliances is enhanced with the knowledge of the long-range cost of energy consumed by the appliance.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
1. After participating in learning experiences, given a choice of two or more modules the student will be able to select the most energy efficient appliance.	1.1 Relate energy conversion to efficiency.

LEARNING EXPERIENCES	INSTRUCTIONAL RESOURCES
1.1a. View transparency.	Appendix: Supplement 32. ''Air conditioner Comparison'' – transparency Overhead projector
1.1b. Determine which air conditioners shown on the transparency you would purchase with the knowledge that both air conditioners have the same cooling capacity or BTUs. Check your answer at the end of this lesson.	
1.1c. Review lesson on basic scientific facts by answering questions related to the First Law of Thermokynamics. 1) Can energy be created? 2) Can energy be destroyed? 3) Can energy be changed in form?	<u>Answers</u> No No Yes
1.1d. Discuss the First Law of Theromodynamics. ''Energy which has been converted from one form to another cannot be completely converted back to its original form.''	
1.1e. Discuss the Second Law of Thermodynamics. ''Any conversion of energy from one form to another results in some of the energy becoming unavailable for further use.''	
1.1f. Explain how burning a lump of coal demonstrates the First Law of Thermodynamics and Second Law in that you cannot get the lump of coal back to the original form once it has been burned. The energy is not lost. It has changed in form to heat and is unavailable for future use.	Coal, wood, or other example may be used

UNIT: Energy Education

COMPETENCY: EE-5. The student will understand how the decision-making process regarding the purchase of major appliances is enhanced with the knowledge of the long-range cost of energy consumed by the appliance.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
	1.2 Make consumer choices based on purchase cost and estimated use costs.

LEARNING EXPERIENCES	INSTRUCTIONAL RESOURCES
1.1g. Write energy efficiency ratio on chalkboard $E = \frac{\text{work or energy--out}}{\text{work or energy--in}} \times 100$	
1.1h. Read handout, ''Energy Efficiency''.	Appendix: Supplement 33; ''Energy Efficiency''
1.1i. Given that not all manufactures design appliances to use energy most efficiently, resulting in a lower purchase price but higher utility bills, discuss the question of consumer control over the efficiency with which electricity is used in the appliances purchased.	
1.2a. Complete the following efficiency problem. 1. View transparency or two air conditioners. 2. Test the efficiency of each appliance by using the formula: 3. Which air conditioner would you purchase? Why? 4. Why would one appliance use more wattage for the same task – a cooling capacity of 14,000 BTU's?	Appendix: Supplement 32; ''Air Conditioner Comparison'' – transparency Overhead projector Answer: $\frac{\text{Work out}}{\text{Work in}} = \frac{\text{cooling capacity}}{\text{wattage}}$ Air Conditioner 1 $\frac{14,000}{2750} = 5.0 = 5\%$ efficient Air conditioner 2 $\frac{14,000}{1380} = 10.0 = 10\%$ efficient
e 1.2b Discuss the question: ''Would the ten year savings with the more efficient model off set the initial cost?''	Answer In some situations the extra efficient model does not save enough money in utility costs to offset the initial cost; however, environmental resources are being saved.

UNIT: Energy Education

COMPETENCY: EE-5. The student will understand how the decision-making process regarding the purchase of major appliances is enhanced with the knowledge of the long-range cost of energy consumed by the appliance.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
	1.3 Compare the energy efficiency of appliances by utilizing the energy efficiency rating labels on the appliances.
	1.4. Identify appliances which have energy efficient ratings.

LEARNING EXPERIENCES	INSTRUCTIONAL RESOURCES
1.3a. Listen to an explanation of the Energy Policy and Conservative Act of 1975	Supplement 34, ''Appliance Labeling'' Duplicate for students
1.3b. Look at and study sample guides in supplement 34	Supplement 34, ''Appliance Labeling''
1.3c. Identify information on the energy guide which would be useful if you were shopping for:	
1. Air conditioner	A) Energy efficiency rating EER B) EER range for all room air conditioners C) BTU's or range of BTU's of cooling capacity D) Operation costs per year by cost per kilowatt-hour and yearly hours of use.
2. Refrigerator	A) Cubic feet B) Estimated yearly energy cost C) Range of energy costs per year for models with similar capacity D) Costs per kilowatt-hour
1.3d. Show sample labels to two adults. Ask whether the adults were aware of the labeling. Explain the label to at least one person who was previously unaware.	Supplement 34
1.4a. Look in catalogs for energy guides on: 1) Air conditioners 2) Refrigerators and freezers 3) A coffee pot	

Answer these questions:

UNIT: Energy Education

COMPETENCY: EE-5. The student will understand how the decision-making process regarding the purchase of major appliances is enhanced with the knowledge of the long-range cost of energy consumed by the appliance.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES

LEARNING EXPERIENCES		INSTRUCTIONAL RESOURCES
1.4a.	continued 1. What was the span of ratings on air conditioners? 2. What was the span of energy costs on refrigerators? 3. Why do you think there is no rating on a coffee pot?	
1.4b.	Call or visit a local appliance dealer and ask for the price of two comparable refrigerators. Ask for the wattage on each. Compare prices. Did the dealer encourage purchase of the inefficient models?	Telephone access
1.4c.	Identify appliances for which labels are mandated by the Energy Policy and Conservation Act of 1975.	Supplement 34 Note: Content will need to be updated by the teachers as this curriculum guide ages.
E	Figure the cost of operating an appliance for ten years by using the Energy Guide. Compare the EER on various models of appliances to see if there would be a sustantial savings by purchasing the more energy efficient model.	Appendix: Supplement 34

UNIT: Energy Education

COMPETENCY: EE-6. The student will recognize the role of natural environment in relation to siting, orientation, landscaping and design of housing for energy conservation.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
1. Given information on the climatic conditions in South Carolina the student will be able to list at least five features of housing, designed for comfort while minimizing mechanical means of achieving comfort.	1.1 Identify housing which utilizes the natural environment to achieve comfort.

LEARNING EXPERIENCES	INSTRUCTIONAL RESOURCES
1.1a. View transparencies of homes around the world. Discuss. 1) the reason the homes were designed as they appear 2) why these designs would or would not be desirable 3) why the design for energy conservative home differs from one region of the U.S. to another, just as it does around the world.	Appendix: Supplement 35 A, B, & C. "Homes Around the World" Note: Planning the use of the natural environment in housing is a means of managing energy consumption, contributes to comfort and can decrease the cost of buying energy. Review the purposes of housing including shelter, comfort, safety, and privacy.
1.1b. View housing (appartment buildings, mobile homes, single dwellings) near the school. In a class discussion speculate about the reasons for their design. Determine if energy use is a consideration in the design.	Houses near the school
1.1c. Listen to a guest invited to your class who lives in a home that was planned in consideration of the natural environment. Ask him/her to explain the benefits of the home in comfort and energy costs. List five ways the guest's house contrasts with a house which is a non-efficient design (example - windows in wrong areas).	Guest speakers
1.1d. Constrast older housing with houses built within the past 20 years. What differences do you notice in relation to design for comfort? What factors may have contributed to design changes? What present conditions are evolutionizing architecture today?	Houses on street near school

UNIT: Energy Education

COMPETENCY. EE-6. The student will recognize the role of natural environment in relation to siting, orientation, landscaping and design of housing for energy conservation.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
	1.2 Name four components of the climatic environment in which a building must operate.
	1.3 Define the terms basic climate condition, climatic liabilities, and climatic assets.
	1.4 Identify the basic climate conditions in which he/she lives.
	1.5 Identify sun factors to consider in housing selection for energy conservation.

LEARNING EXPERIENCES	INSTRUCTIONAL RESOURCES
1.2a. Read about the role of humidity, temperature, wind and sun in defining the climate.	Appendix: Supplement 36; ''Climate, Comfort, and Your Building''
1.2b. Write a paragraph (3-6 sentences) to summarize the role of humidity, temperature, wind and the sun in defining the climate. e	
1.3a. Read ''How to Define Your Climate''.	Appendix: Supplement 37; ''How to Define Your Climate''
1.3b. Write a definition for: 1) basic climate condition 2) climate libilities 3) climate assests	
1.4a. Read Climate 7 or Climate 8 as it applies to your areas of South Carolina.	Appendix: Supplement 38; ''Climate 7'' Appendix: Supplement 39; ''Climate 8''
1.4b. Name 4 design priorities to be used in your climate area.	
1.5a. View transparency, Sun Angles for Winter and Summer, and discuss the following: The sun's path of rising north of east to its point of setting north of west in the summer and rising south of east and setting south of west in the winter has implications for the design, orientation, and landscaping of the residence to maximize the winter sun and minimize the summer sun.	Appendix: Supplement 40; ''Sun Angles for Winter and Summer''

UNIT: Energy Education

COMPETENCY: EE-6. The student will recognize the role of natural environment in relation to siting, orientation, landscaping and design of housing for energy conservation.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
	1.6 Identify wind factor to consider in housing selection for energy conservation.

LEARNING EXPERIENCES	INSTRUCTIONAL RESOURCES
1.5b. Discuss the following recommendations from handout, Climate 7 or Climate 8, which relate to the use and control of the sun in South Carolina. 1) Let the sun shine in when it's too cool for comfort. 2) Protect from sun when it's too hot for comfort. Determine whether these principles are followed in the design of your home. List how you would use these recommendations when selecting an apartment or mobile home placement. e	Appendix: Supplement 38; ''Climate 7'' and Supplement 39; ''Climate 8''
1.6a. Discuss the following principles. 1) Wind factors are generally fixed for any region or geographic area and can be taken into account in housing selection. 2) Maximum consideration of wind factors in housing include a knowledge of the west or east prevailing wind patterns and seasonal and regional variations.	
1.6b. Read the following recommendations from either ''Climate 7'' or Climate 8'' which relate to the use of wind in South Carolina. If you live in the Charleston, SC region:	Appendix: Supplement 38; ''Climate 7'' and Supplement 39; ''Climate 8''

UNIT: Energy Education

COMPETENCY: EE-6. The student will recognize the role of natural environment in relation to siting, orientation, landscaping and design of housing for energy conservation.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
	1.7 Relate humidity level to comfort.

LEARNING EXPERIENCES		INSTRUCTIONAL RESOURCES
1.6b.	continued 1) Allow wind to ventilate and cool when it's too hot for comfort. 2) Allow ventilation, but avoid infiltration. Determine whether these principles are followed in the design of your home. e Discuss how you would use these recommendations when selecting an apartment or mobile home placement.	
1.7a.	Read handout, ''Moisture Control''.	Appendix: Supplement 41; ''Controlling Internal Moisture Problems in the Home''
1.7b.	Define humidity	
1.7c.	Determine which measures have been taken in your own home to control moisture.	
E	List five features of housing, designed for comfort while minimizing mechanical means of acheiving comfort.	

UNIT: Energy Education

COMPETENCY: EE-7. The student will use knowledge of the natural environment in selection of the site, orientation, landscaping and design of housing for energy conservation.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
1. The student will analyze the site orientation and landscape of his/her home and list evidence of application of four energy-conserving principles.	1.1 Define site as it relates to housing.
	1.2 Define orientation as it relates to housing.

LEARNING EXPERIENCES		INSTRUCTIONAL RESOURCES
1.1a.	Difine site using a dictionary	
1.1b.	Participate in discussion: ''Why is the site the first consideration in selecting housing?''	
1.1c.	Complete No. 1 on worksheet: ''Energy Conservation Considerations in Planning Housing.''	Appendix: Supplement 42; ''Energy Conservation Considerations in Planning Housing Worksheet''
1.1d.	Discuss the major considerations in selecting a site.	
1.1e.	Study checklist, ''Deciding Where to Live.'' Note that energy was not listed as a consideration on the checklist. Check those items which would influence energy use.	Appendix: Supplement 43; ''Deciding Where to Live''
1.2a.	Read ''Sun/Wind Orientation.''	Appendix: Supplement 44A; ''Sun Orientation/ Wind Orientation'' Appendix: Supplement 44B; ''General principles of Orientation''
1.2b.	Define orientation.	
1.2c.	Use a compass to check the orientation of the classroom.	Compass
1.2d	Complete question No. 2 on worksheet begun in activity 1.1c by drawing a sketch of your homes and explaining why the house was oriented in that direction (example - the front door faces the road).	

UNIT: Energy Education

COMPETENCY: EE-7. The student will use knowledge of the natural environment in selection of the site, orientation, landscaping and design of housing for energy conservation.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
	1.3 Relate the sun's path to home orientation and room placement
	1.4 Recognize wind patterns and the affect of large geographic features such as slopes, hills, and lakes on the wind reaching the home.

	LEARNING EXPERIENCES	INSTRUCTIONAL RESOURCES
1.3a.	Review path of sun. Discuss how your home reflects application of the principle that for warmth in the winter and coolness in the summer, the largest area (principle facades) of the house should face south.	Appendix: Supplement 40; ''Sun Angles for Winter and Summer'' transparency
1.3b.	Read ''Room Orientation.''	Appendix: Supplement 45; ''Room Orientation''
1.3c	Complete activity in ''Room Orientation.'' Point out which room(s) in your home would best be suited for growing plants.	
1.3d	View transparency of the overhang noting how it shades the house in summer and allows the sun to shine in windows/doors in the winter. Discuss what can be done in South Carolina to cut down on the summer sun coming in the south windows in the summertime.	Appendix: Supplement 46; ''Shading Window Areas.''
1.4a.	View transparency, ''The Wind.'' Discuss how wind patterns can affect the warmth or coolness of a home.	Appendix: Supplement 47A; ''The Wind''
1.4b	Answer question No. 3 on the worksheet begin in activity 1.1c.	
1.4c.	View transparency, ''Geographic Features'', to see that large geographic features can affect the winds which reach your home.	Appendix: Supplement 47B; ''Geographic Features''
1.4d.	Answer question No. 4 on the worksheet.	

UNIT: Energy Education

COMPETENCY: EE-7. The student will use knowledge of the natural environment in selection of the site, orientation, landscaping and design of housing for energy conservation.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
	1.5 Recognize the contribution of landscaping to energy conservation.

LEARNING EXPERIENCES		INSTRUCTIONAL RESOURCES
1.4e.	View transparency, ''Slopes and Hills,'' to see that slopes and hills can be used to help protect homes from the wind.	Appendix: Supplement 47C; ''Slopes and Hills.''
1.4f.	List three geographical features to consider when deciding upon the site of a home.	
1.5a.	Define landscaping.	Landscaping is defined as the planned placement of trees and plants.
1.5b.	Discuss the idea: Landscaping can serve several purposes. Properly planned landscaping provides wind protection, shading, control of ventilation, and tempering of the environment.''	
1.5c.	View transparency, ''Land Plantings - Deciduous.''	Appendix: 48A; ''Large Plantings - Deciduous.''
1.5d.	View transparency, ''Large Plantings - Evergreens.''	Appendix: Supplement 48B; ''Large Plantings - Evergreens.''
1.5e.	View transparency, ''Natural Ventilation with Plantings.'' Discuss the idea: ''Trees can provide protection on a small scale too.'' Even vines on homes can help cool in the summer.	Appendix: Supplement 49; ''Natural Ventilation with Plantings.''
1.5f.	View transparency, ''Tempering.''	Appendix: Supplement 50; ''Tempering.''
1.5g.	View transparency, ''Shading.'' Answer question No. 5 on the worksheet begun in activity 1.1c.	Appendix: Supplement 51; ''Shading.''

UNIT: Energy Education

COMPETENCY: EE-7. The student will use knowledge of the natural environment in selection of the site, orientation, landscaping and design of housing for energy conservation.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
2. The student will analyze the design of his/her home for evidence of application of energy conservation principles, and list four of his/her findings.	2.1 List aspects of design to consider in selecting energy conserving housing.
	2.2 Determine the importance of the shape and size of the house in relation to heat loss and heat gain.
	2.3 Consider how insulation, overhang, color, and pitch of roof affect energy conservation in a home.

LEARNING EXPERIENCES		INSTRUCTIONAL RESOURCES
1.5h.	Write for additional information on one of the topics in this lesson from either: 1. Forest Service 2. Clemson Extension Service	
E	Review four elements of site orientation of your own home as reached on the worksheet and give a positive or negative rating. Explain the rating.	
2.1a.	Define design as it relates to housing.	
2.1b.	Read questions 6-12 on the activity sheet begun in activity 1.1c. List the aspects or design which affect energy conservation in a house.	Students should include these aspects of design in their list. 1. Shape and size (volume) 2. Roof 3. Foundation 4. Structures a. Building mass and materials b. Color selection c. Window placement d. Door placement
2.2a.	Read handout, ''Design/Volume.''	Appendix: Supplement 52A; ''Design/Volume.''
2.2b.	View transparency, ''Design/Volume'' and discuss which are the optimal shapes for an energy conserving home.	Appendix: Supplement 52B; Transparency, ''Design/Volume''
2.2c.	Complete question No. 6 on worksheet begun in activity 1.1c.	
e 2.3a.	Read handout, ''Roofs.''	Appendix: Supplement 53A; ''Roofs''
2.3b.	Review transparency, ''Roof Pitches''	Appendix: Supplement 53B; ''Roof Pitches''

UNIT: Energy Education

COMPETENCY: EE-7. The student will use knowledge of the natural environment in selection of the site, orientation, landscaping and design of housing for energy conservation.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
	2.4 Consider how foundations affect the energy conservation in a home.
	2.5 Consider the affect of structual aspects (windows, doors, walls, building materials, color) have on energy conservation.

LEARNING EXPERIENCES		INSTRUCTIONAL RESOURCES
2.3c.	Discuss the four features of roofs to be considered when planning for energy efficiency: 1. Insulation 2. Overhang 3. Color 4. Pitch	
2.3d.	Complete question No. 7 on worksheet begin in activity 1.1c.	
	e	
2.4a.	Read handout, ''Foundations.''	Appendix: Supplement 54A; ''Foundations''
2.4b.	View transparency, ''Foundations.'' Discuss the climate each type picture is best suited for.	Appendix: Supplement 54B; transparency, ''Foundations''
2.4c.	Complete questions No. 8 on worksheet begun in activity 1.1c.	
	e	
2.5a.	Read handout, ''Windows and Doors.''	Appendix: Supplement 55A; hand out, ''Windows and Doors''
2.5b.	Participate in class discussion about how window placement can affect ventialtion.	
2.5c.	List eight ways to reduce the heating and cooling load of a home.	
2.5d.	Complete activity, ''Window Area Investigation.''	Appendix: Supplement 55B; Activity Sheet, ''Window Area Investigation''
2.5e.	Complete questions No. 9 and No. 10 on worksheet begun in activity 1.1c.	
	e	
2.5f.	Read handout, ''Walls and Building Materials,'' and participate in class discussion on the five elements of an energy conserving wall.	Appendix: Supplement 56; handout ''Walls''

UNIT: Energy Education

COMPETENCY: EE-7. The student will use knowledge of the natural environment in selection of the site,orientation, landscaping and design of housing for energy conservation.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES

LEARNING EXPERIENCES	INSTRUCTIONAL RESOURCES
2.5g. Complete question No. 11 on the worksheet begun in activity 1.1c.	
2.5h. Discuss this practice carried out in Israel: "Houses are traditionally whitewashed in spring to reflect the summer sun, and then in autumn the rain washes it off, exposing the darker surface to absorb the winter sun."	
2.5i. Complete question No. 12 on the worksheet begun in activity 1.1c.	
2.5j. In small groups, review worksheet and discuss ways students' homes could be made more energy efficient.	
E Review worksheet and list evidence of 4 energy conservation principles.	

UNIT: Energy Education

COMPETENCY: EE-8. The student will understand the relationship between the control of air infiltration/exfiltration and heat conduction to material and methods used to control heat transfer.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
1. After completing learning experiences, the student will list eight ways to control infiltration and exfiltration to control heat gain in summer and heat loss in winter.	1.1 Describe how air infiltration and exfiltration effects energy conservation in a home. 1.2 Name ways to stop air infiltration/ exfiltration. 1.3 Describe how the principle of heat conduction relates to insulation.

LEARNING EXPERIENCES		INSTRUCTIONAL RESOURCES
1.1a.	Read handout, ''Infiltration''	Appendix: Supplement 57; ''Infiltration''
1.1b.	Define air infiltration.	
1.1c.	From material you read about infiltration, discuss the definition of infiltration.	
1.2a.	Locate areas in the classroom where air could leak in or out.	
1.2b.	View transparencies illustrating air infiltration and exfiltration.	Appendix: Supplements 58A & B. ''Energy Balance in Summer;'' ''Energy Balance in Winter.''
1.2c	Name 2 approaches to decreas infiltration/exfiltration.	
1.2d	Read handouts ''Weather Striping'' and ''Fuel Saving.'' Which materials are permanently installed? Which are temporary or seasonal?	Appendix: Supplement 59 A & B. ''Home Energy Guide - ''Weather Stripping'' Home Energy Guide - ''Fuel Saving''
1.2e.	Complete checklist, ''Weatherproofing Investigation.''	Appendix: Supplement 60; ''Weatherproofing Investigation''
1.2f.	Complete module on ''Caulking Seams and Cracks.''	S.C. Department of Education. Housing and Home Furnishings Curriculum Guide, Module 58, 1981
1.2g.	List in your notebook 5 conserving habits.	
	e	
1.3a	Read about the purposes and types of insulation.	Sherwood, R.F., Homes Today and Tomorrow, pp. 86-87 Appendix: Supplement 61 ''Additional Insulation''
		Appendix: Supplement 62; ''Insulation Investigation''

UNIT: .

COMPETENCY: EE-8. The student will understand the relationship between the control of air infiltration/exfiltration and heat conduction to materials and methods used to control heat transfer.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
	1.4 Describe how R-value is ralated to energy conservation.
	1.5 Identify ways housing has been adapted to the environment in various countries.

LEARNING EXPERIENCES		INSTRUCTIONAL RESOURCES
1.3b.	Formulate a definition for insulation	
1.3c.	Complete ''Residential Energy Checklist''	Appendix: Supplement 63; ''Residential Energy Checklist''
1.3d.	Name parts of a home that need insulation and identify the most appropriate insulation materials for each part.	
1.4a.	Define R-value.	Review supplement 61; ''Additional Insulation''
1.4b.	Review handout ''R-values for common Building Materials.''	Appendix: Supplement 64; ''R-values for Common Building Materials.''
1.4c.	Look at actual examples of wall materials including wood, concrete block, brick, aluminum and vinyl siding. Arrange the materials in order from lowest to highest R-value.	Samples of building materials.
1.5a.	View filmstrip, ''Nature, Man and Architecture.''	''Nature, Man, and Architecture.'' 50-frame filmstrip
1.5b.	Identify the aspect of the environment that is being controlled in the various frames of the filmstrip.	NOTE: This filmstrip makes apparent that when conditions have been roughly the same, people of different times, races and lands have found surprisingly similar solutions for their problems.
1.5c.	Predict how present day American housing may be described centuries from now if someone were showing slides of our housing.	
E	List 8 ways air infiltration/exfiltration can be controlled to prevent heat loss in winter and heat gain in summer.	

UNIT: Energy Education

COMPETENCY: EE-8. The student will understand the relationship between the control of air infiltration/exfiltration and heat conduction to material and methods used to control heat transfer.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
2. Given a description of a house, the student will be able to list 4 features of the home which indicate use of passive solar heat.	2.1 Recognize advantages of using solar energy in a passive way in the home.
3. Given a description of a ready built home the student will be able to list 5 ways in which the house can be retrofitted to make it energy efficient.	3.1 Identify categories of American housing.
	3.2 Determine the potential for involvement of the homeowner in energy-related decisions in various types of housing situations.

LEARNING EXPERIENCES		INSTRUCTIONAL RESOURCES
2.1a.	Define passive use of solar energy.	Appendix: Supplement 65A
2.1b.	View floor plan illustrations designed to maximize passive solar energy. Identify features of the floor plan which differ from more conventional floor plans.	Appendix: Supplement 65B and C; ''Floor Plans for Passive Solar Homes'' NOTE: Emphasize that by increasing the direct use of continuous energy sources we can decrease depletion of natural resources and the portion of our budgets which goes towards purchasing energy.
E	From the floor plans used in 2.1b, list 4 features which indicate use of passive solar heat.	
3.1a.	Participate in a class discussion of the categories of American housing including: a) construction method (manufactured or stick built) b) multi-versus single-family dwellings c) ownership or rental. *Stick built refers to housing built totally at the site; manufactured refers to housing such as mobile homes, panelized, precut and pre-fabricated.	Family Housing Handbook. Ames, Iowa Midwest Plan Service, Iowa State University, 1971. Use as a general reference.
3.1b.	Collect pictures of housing representing each category and make a flannel board display.	
3.2a.	Read Supplement ''Housing Selections.''	Appendix: Supplement 66; ''Housing Selection.''
3.2b.	Name the features to consider when selecting a home to rent or buy. e	

UNIT: Energy Education

COMPETENCY: EE-8. The student will understand the relationships between the control of air infiltration/exfiltration and heat conduction to materials and methods used to control heat transfer.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
4. After completing activities to become familiar with construction features of a new house, the student will be able to list 5 ways design of these features can contribute to energy conservation.	4.1 Name the purposes of windows and doors in the home and principles which govern the design and placement of windows and doors to maximize energy efficiency.

LEARNING EXPERIENCES		INSTRUCTIONAL RESOURCES
3.3c.	Define retrofitting	Answer: Retrofitting is the process of altering an existing structure to improve the energy efficiency.
3.2d.	Rate potential for energy related decisions using the supplement ''Can Consumers Choose Energy Conserving Housing?''	Appendix: Supplement 67; ''Can Consumers Choose Energy Conserving Housing?''
3.2e.	Read handout ''Apartments and Condominiums''	Appendix: Supplement 68; ''Apartments and Condominiums''
3.2f.	List 3 features to look for in apartments and condominiums which would effect energy use efficiency.	
	e	
3.2g.	Read handout ''Mobile Homes.''	Appendix: Supplement 69; ''Mobile Homes''
3.2h.	List 4 measures which may be taken after a Mobile Home is purchased to ensure greater energy efficiency.	
3.2i.	Read handout ''Older Homes.''	Appendix: Supplement 70; ''Older Homes''
E	Name 4 steps which may be taken with an older home to improve its energy efficiency.	
4.1a.	Read references on windows and doors to learn about the purposes and principles of window and door placement.	Sherwood, R.F. Homes Today and Tomorrow, pp. 92-97 Appendix: Supplement 55A;''Windows and Doors''
4.1b.	List 5 principles which may be applied to the design of windows and doors to reduce the heating and cooling load of a home.	

UNIT: Energy Education

COMPETENCY: EE-8. The student will understand the relationship between the control of air infiltration/exfiltration and heat conduction to material and methods used to control heat transfer.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
	4.2 Identifying different types of roofing materials and cite advantages and disadvantages for different materials, styles, colors.

LEARNING EXPERIENCES	INSTRUCTIONAL RESOURCES
4.1c. Complete the activity to determine the percentage of squarefootage of window area to total wall area total floor ares. e	Appendix: Supplement 71A; ''Window area Investigation''
4.1d. Visit a building supply store or use newspaper ads to learn about the cost of different types of windows and doors. Ask a salesperson to describe the advantages and disadvantages of different types.	
4.1e. Read about reducing heat gain/loss through windows and doors in handout.	Appendix: Supplement 71B; ''Reducing Infiltration/Exfiltration Through Windows and Doors''
4.1f. Summarize readings and discussions by identifying advantages and disadvantages of different types of windows and doors. e	NAHB, Designing, Building and Selling Energy Conserving Homes, p. 63. Washington, D.C. 1978.
4.2a. Read about roof coverings and styles.	Sherwood, R.F. Homes Today and Tomorrow, ''Roof Styles'' pp. 133-134 'Roofing' and ''Other Construction Details'' pp. 84-85. Appendix: Supplement 72; ''Roofing''
4.2b. Make a list of the advantage of different roofing materials. Relate these advantages and disadvantages to energy efficiency concepts of: 1. life cycle costing 2. R-values e	
4.2c. Listen to a guest speaker (a local builder) talk about relative costs of building different types of roofs.	

UNIT: Energy Education

COMPETENCY: EE–8 The student will understand the relationship between the control of air infiltration/exfiltration and heat conduction to material and methods used to control heat transfer.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
	4.3 Name different materials used for exterior finishes and compare them for durability, maintenance, R-Value, life cycle costs, appearance.
	4.4 Identify the relationship between moisture control and energy conservation.
	4.5 Recognize the purpose of building codes for improving the quality of housing.

LEARNING EXPERIENCES		INSTRUCTIONAL RESOURCES
4.3a.	Read references about exterior wall materials.	Sherwood, R.F., Homes Today and Tomorrow, ''Exterior Wall Coverings'' p. 84 Appendix: Supplement 73; ''Exterior Walls''
4.3b.	As a class, rate the various factors of exterior wall finishes on a scale to determine ''good'', better, ''best'' Include factors such as: 1. durability 2. maintenance 3. R-value 4. life cycle costs 5. appearance 6. availabiiity	
4.3c.	Define and explain importance of: 1. parging 2. weep hole	Appendix: Supplement 74; ''Masonry Walls''
4.4a.	Read references about vapor barriers, ''Controlling Internal Moisture Problems in the Home.''	Appendix: Supplement 41; Engineering and Technology Guide, ''Controlling internal Moisture Problems in the Home.
4.4b.	Explain the effects of proper and inproper placement of vapor barriers on the life and energy efficiency of exterior finishes.	
4.5a.	Read handout ''New Homes'' and discuss with the class, practices which can be applied when building a new home. Summarize the discussion with a list of 5 features listed on the chalkboard.	Appendix: Supplement 75; ''New Homes''
4.5b.	Define building code and discuss its purpose.	

UNIT: Energy Education

COMPETENCY: EE-8. The student will understand the relationship between the control of air infiltration/exfiltration and heat conduction to material and methods used to control heat transfer.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES

LEARNING EXPERIENCES		INSTRUCTIONAL RESOURCES
4.5c.	Discuss the reasons builders continue to build inefficeint housing. (Reasons include: assumed abundance of energy, rate of mobility, cost of upgrading building standards, desire for convenience, bias against new building methods, outdated building codes.)	
4.5d.	Listen to a presentation by guest speaker, a local building code inspector, discuss the importance of building codes and to describe how changes are made in the code to encompass new and improved building methods.	Appendix: Supplement 36; ''Climate, Comfort, and Your Building.''
E	List 5 ways the design of the construction features of a house can contribute to energy conservation.	

UNIT: Energy Education

COMPETENCY: EE-9. The student will classify various aspects of the active solar system, relate actual solar system to house design and predict the possible lifestyle changes necessitated by solar heating.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
1. Given a description of a house designed to utilize solar energy in an active manner, the student will classify various aspects of the solar system. NOTE: This lesson on the use of solar energy does not cover the use of solar energy for cooling the residence, nor does it discuss solar forms in which the sun's energy is converted to electricity.	1.1 Define active use of solar energy as it applies to the home. 1.2 Recognize the major components of an active solar system used for heating a home.

LEARNING EXPERIENCES		INSTRUCTIONAL RESOURCES
1.1a.	Read ''Solar Energy''	Appendix: Supplement 76; ''Solar Energy.''
1.1b.	List at least 4 ways solar energy is presently being used.	
1.1c.	Point out 2 disadvantages of solar energy and 3 advantages of solar energy.	
1.1d.	Discuss the idea: ''The sun is the ultimate energy source of food and wood fuel, the source of the chemical energy of the fossil fuels, and the source of wind and hydro energy.''	
1.1e	Read ''Solar Technology''	Supplement 77
1.1f.	Define active use of solar energy.	
1.1g	Differentiate between passive use and active use of solar energy.	Previous lesson No. 8.
	e	
1.2a.	Study the floor plan of the module solar homes constructed on the Clemson University campus. List features of these homes which are different from a non-solar home.	Appendix: Supplement 78; ''Solar Research Homes.''
1.2b.	Locate homes in the community which use solar energy in an active manner.	Local family members who live in a solar heated home.

UNIT: Energy Education

COMPETENCY: EE-9. The student will classify various aspects of the active solar system, relate active solar system to house design and predict the possible lifestyle changes necessitated by solar heating.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
2. Given a description of a house designed to use solar energy in an active manner the student will be able to point out how solar heating systems affect the design of the house.	2.1 Contrast the design and energy-conserving features of a home built to maximize energy conservation with a home built with low energy-conserving priorities.

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LEARNING EXPERIENCES		INSTRUCTIONAL RESOURCES
1.2c.	Take a field trip to a solar home. Ask the family questions about living in the solar home.	
1.2d.	Check the yellow pages to see if there are any solar construction firms in the area served by the school. Contact company to serve as class resource.	Phone Book
1.2e.	Inquire about the initial cost of installation of a solar energy system and the number of years necessary for ''pay-back.'' How much were utility costs affected in the first year of use?	
1.2f.	View films entitled: ''Project Sage'' ''Putting the Sun to Work''	16 mm film proj. ''Project Sage'' 8¼ min. ''Putting the Sun to Work'' 5 min.
1.2g.	Work cooperatively with the industrial arts vocational area to design a model solar collector. List the water temperature on a sunny day.	
E	List the basic parts for an active solar heating system.	1. Collection device to collect the sun's rays. 2. A medium to transfer the heat to a storage device which is to contain the heat until the time it is needed in the house. 3. A means to transfer the heat to the rooms of the house. 4. A back-up heating system.
2.1a.	Remembering that applications of solar energy to heat residence necessitates design considerations for collection, transfer, storage, and distribution of the heat collect pictures of a variety of solar home. Choose a design in which you would like to live. Try to include some ''do-it-yourself'' styles.	Opaque projector.

UNIT: Energy Education

COMPETENCY: EE-9. The student will classify various aspects of the active solar system, relate actual solar system to house design and predict the possible lifestyle changes necessitated by solar heating.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
	2.2 Recognize the environmental advantage of the active and passive use of solar energy in housing.

LEARNING EXPERIENCES	INSTRUCTIONAL RESOURCES
2.1b. Read about the ''Geohouse'' in National Geographic. It has no floor plan. It is a set of principles and therefore more likely to be useful to students in the future. Emphasize the use of earth berms, since the earth is a constant temperature once the builder get below the frost line.	''Modern House, Ancient Architecture.'' National Geographic: A Special Report in the Public Interest, Energy: Facing up to the Problem, Getting Down to Solutions. Washington, DC. February, 1981, pp. 42, 43. Copies of the book are $1.15 Order from: National Geographic Society, Dept. 5000, Washington, DC 20036.
2.1c. List 4 ways solar energy usage might affect the interior design of the home. Possible answers - 1) Sun might fade materials which are exposed. 2) Areas may need to be designed so heat can pass freely (example, use of lofts and use of open areas). 3) Masonry may need to be used extensively on the south side to collect the sun's heat. 4) If a greenhouse is used, numerous adjustments will need to be made.	
2.2a. Discuss how a combination of passive and active use of solar energy and the use of the environment to best advantage in housing can decrease the amount of fossil fuel energy sources used in the residence and the cost of energy. Emphasize that the sun's heat is free and a continuous energy source.	
E Name 5 ways the solar heated homes in supplement 78 are different in design from a non-solar heated home.	

UNIT: Energy Education

COMPETENCY: EE-9. The student will classify various aspects of the active solar system, relate actual solar system to house design and predict the possible lifestyle changes necessitated by solar heating.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
3. After completing learning experiences, the student will be able to name possible lifestyle changes due to use of solar energy.	3.1 Identify lifestyle changes which would accompany the use of solar energy for space heating and water heating as predicted with the present solar technology.
	3.2 Identify the reasons for wide-spread acceptance or rejection of solar energy as a home-heating source.

LEARNING EXPERIENCES	INSTRUCTIONAL RESOURCES
3.1a. Interview individuals living in a solar-heated home to see if they have to alter their living in any way for use of hot water. What were the individuals' responses to the design of the home? Ask about lifestyle changes recommended for the use of solar energy in a direct manner in the home related to the time that hot water will be available and to controlling the solar-heating source for comfort. Lifestyle changes may be minimized with use of a conventional back-up space and water heating system and with management of the solar system.	
3.2a. Consider in a class discussion that the acceptability of solar energy will depend on such factors as the technology available, ease of conversion of existing homes to solar, governmental support, cost, lifestyle changes necessitated, and the cost of use of fossil fuel sources.	
3.2b. Check a local contractor to see if a solar system could be applied to an existing home. NOTE: This is possible. The question is, whether or not the application is readily available. What is the cost?	Resource person
3.3c. Call an income tax consultant to learn the income tax incentive for use of solar energy.	

UNIT:

COMPETENCY: EE-9. The student will classify various aspects of the active solars system, relate actual solar system to house design and predict the possible lifestyle changes necessitated by solar heating.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES

LEARNING EXPERIENCES		INSTRUCTIONAL RESOURCES
3.4d	Check the goals of the U.S. Department of Energy to see how much emphasis is being placed on solar and on nuclear energy.	U.S. Department of Energy publications.
E	Name 4 lifestyle changes which would be necessitated by the use of solar energy heating and hot water systems.	

UNIT:

COMPETENCY: EE–10. The student will understand the energy options available and describe the feasibility of the options for future use.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
1. Given a description of an energy source which is presently not in common use, the student will predict the acceptability of the source in America.	1.1 Recognize the importance of the ease of converting energy sources to electrical power in predicting the usability of energy sources by consumers.
	1.2 List factors which determine the acceptability of alternative energy sources.

LEARNING EXPERIENCES	INSTRUCTIONAL RESOURCES
1.1a. Read the list of sources of energy from the chalkboard as follows: 1. cornstalks 2. windpower 3. geothermal What do each of the sources have in common? Possible Answer: All can be converted to electricity. Why would conversion to electrical energy be important. Point out that energy sources which may be converted to electricity provide an opportunity for consumers to use the energy delivery system presently in homes and thereby decreases the need to change the lifestyle of the individual or family.	Chalkboard
1.1b. View the film: ''Energy for the Future'' or a combination of the following: ''Coal to kilowatts'' ''From Rubbish to Riches'' ''Energy: The Ultimate Problem''	
1.2a. Divide into 4 groups. Each group choose an energy source as follows: 1. nuclear power 2. windpower 3. cornstalks 4. ocean tides Each group is to assume that they are building a home which will only have available the energy source assigned. What are questions the homebuilder would have about the soure of energy?	

UNIT: Energy Education

COMPETENCY: EE-10. The student will understand the energy options available and feasibility of the options for future use.

PERFORMANCE OBJECTIVES	PERFORMANCE GUIDES
	1.3 List and define at least 10 sources of energy.
	1.4 Recognize the controversy associated with the development of some energy sources.

LEARNING EXPERIENCES	INSTRUCTIONAL RESOURCES
Emphasize the fact that the acceptance of energy sources is dependent upon the following: 1. Availability of the source 2. Ease of getting the energy source to homes 3. Flexibility of use of the source 4. Cost 5. Safety of use 6. Degree of public environmental consciousness 7. Tradition (local acceptance)	
1.3a. Read handout, ''Outline of Facts about Energy Sources'', which summarizes sources briefly and in outline form.	Appendix: Supplement 79; ''Outline of Facts About Energy Sources.''
1.3b. View films which project future sources of energy.	Appendix: Annotated Film/Filmstrip list
1.3c. Choose a partner. Select energy source. Assume you are the company public relations person for the energy source assigned and prepare a brief overview of the desirability of the source to present to the class.	
1.4a. Participate in a class discussion on the concepts of ''hard paths'' and ''soft energy paths.''	Appendix: Supplement 80; Lovins, A. Soft Energy Paths: Toward a Durable Peace. New York: Harper & Row, Pub., 1977. viii-xvii.
1.4b. Clip newspaper articles which show controversy (example - nuclear waste disposal).	
E Summarize by asking what the future is for the use of: gas geothermal synfuels oil nuclear coal solar How can consumers have any impact on the source of energy used?	

TIME LINE

While viewing the film, complete the time line by writing in energy sources at intervals along the line to represent the period of time the energy source was used.

1776 ——— 1976 ——— * ——— 2000 and beyond

Nuclear Fission
Nuclear Fusion
Solar
Waste Conversion
Geothermal
Wind
Ocean Tides
Coal Uses

*NOTE: Teacher fill in present date in this blank.

TIME LINE

While viewing the film, complete the time line by writing in energy sources at intervals along the line to represent the period of time the energy source was used.

1776 ——— 1976 ——— 2000 and beyond

SECTION 1 ENERGY: THE AMERICAN PERSPECTIVE [26]

OBJECTIVE: TO PROVIDE THE HOME ECONOMICS TEACHER WITH INFORMATION ON THE HISTORICAL USE AND DEVELOPMENT OF AMERICAN ENERGY RESOURCES (1800-1974) AND TO PROVIDE THE TEACHER WITH INFORMATION ON PRESENT AND PROJECTED PATTERNS OF ENERGY CONSUMPTION (1975-1990)

HISTORICAL PERSPECTIVE

Energy Resources in the Nineteenth Century

The major sources of energy in the U.S. for most of the nineteenth century were wood, water, and wind. Wood was important to both home and industry as a source of fuel and heat. It was the principal fuel for railroads and steamboats until about 1870, and was used in the form of charcoal by about half the iron producers in 1850. The abundance of wood during the first half of the nineteenth century resulted in a great deal of misuse. Most of it was consumed in open fireplaces rather than in the more efficient Franklin stove. (As much as 90 percent of the heat produced by burning wood in old-style fireplaces goes up the chimney--not a very efficient way to use fuel!) There are no statistics on the number of waterwheels and windmills that existed across North America in the 1800's, but both were significant sources of power for farms and industries.

Work derived from animals was the major source of energy for the U.S. well into the second half of the nineteenth century and, in absolute terms, it continued to increase until 1910. The following table compares animal work output to inanimate work output in terms of billion horsepower hours:

Year	Work Output (billion horsepower hours) From Work Animals	From All Inanimate Energy Sources
1850	5.4	3.6
1860	7.6	5.9
1870	8.4	8.5
1880	11.1	16.0
1890	14.4	30.3
1900	16.9	57.6
1910	19.0	142.8
1920	15.2	268.1

One horsepower is defined as the work performed or energy consumed by working at the rate of one horsepower for one hour; it is equal to 1,980,000 foot-pounds (one foot-pound is equal to the work done in raising one pound avoirdupois against the force of gravity the height of one foot) and is approximately equal to the output of a motor consuming 750 watts of power for one hour.

Although coal was used by the Hopi Indians in Arizona as early as 1000 A.D., American Colonialists did not mine it because wood was so abundant. America, unlike Britain, did not use coal during its early industrialization until, by the middle of the nineteenth century, it was realized that two tons of wood could be replaced by half a ton of coal at half the cost. As wood became scarce and more expensive, and with techniques for burning coal resulting in greater efficiency (such as coal-fired steam generators), the use of coal increased. By 1895 half of America's energy came from wood, and half from coal.

By the middle of the nineteenth century, efficient and cheap lubricants and illuminants were needed to replace scarce and expensive whale oils. The Pennsylvania Rock Oil Company struck oil in 1859. During that year, 4,215,000 barrels of oil (the equivalent in energy content to nearly a million tons of coal) were produced in the U.S. Only 30 years later, fuel oil accounted for 35 percent of total petroleum sales. During the nineteenth century, petroleum production increased at a faster rate than domestic consumption.

Natural gas has not always been a valuable energy source. During the first half of the nineteenth century it was considered a nuisance whenever it was encountered in water and salt wells. Gas was often found during searches for petroleum, but it was still considered a waste product and was burned off at the well; wood and coal provided necessary heating, and kerosene was used for lighting. There were, however, exceptions to the general attitude toward natural gas. Fredonia, New York, was using natural gas as fuel for lights in 1821, and by the late 1860's it was used on a small scale for making firebricks and as a source of lampblack for printers' ink. Furthermore, isolated experiments were being made on natural gas by iron and steel works near Pittsburgh to determine whether or not gas could be used for space heating and steam generation.

In 1878, a large gas well was discovered near Murrysville, Pennsylvania, and in 1883 a pipeline running from this well to Pittsburgh was opened. In the early 1880's serious searches for natural gas were conducted in Ohio, and in 1884 the searches resulted in the discovery of large gas reservoirs which were subsequently tapped in order to supply local industrial plants with cheap fuel. But natural gas still could not be used extensively because an adequate way to transport it had not been developed.

With the new energy sources came many new technologies. The electric light was invented in 1879, but more important was the world's first electrical power generating and distribution system built in 1882 by Thomas Edison in New York. Less than a month later, the first hydroelectric

power facility began generating on the Fox River in Appleton, Wisconsin. The hydroelectric plant at Niagra Falls began operating in 1896, and by 1900 hydroelectric power accounted for about 2.6 percent of all U.S. energy consumption, or about 52 percent of all the electricity generation.

The following table shows the total U.S. energy consumption in 1850 and 1900:

Energy Resource	1850	1900
Coal	9.3%	71.4%
Oil	---	2.4
Natural Gas	---	2.6
Hydropower	---	2.6
Fuel Wood	90.7	21.0

Source: Clark, p. 36.

Energy Resources From 1900 to World War II

From 1900 to World War II, wood comprised only a small fraction of the total energy pool, but the amount of wood used was still substantial and surpassed hydropower as an energy source well into the 1940's. It was used mostly for heating and cooking in rural homes. Hydropower before 1900 accounted for 57 percent of all electricity generated but by 1950 accounted for only one third; in 1975 it provided less than 4 percent of our electricity. Electricity generation, however, increased slowly but steadily until the end of World War I when it began to accelerate rapidly; since the mid-1930's the annual per capita growth rate for electricity has been seven to nine percent, except for the years of World War II.

A dramatic shift also had occurred in the use of coal in the early twentieth century. Between 1885 and World War I its production had doubled, but after 1920 it began to drop rapidly. In 10 years the ratio of coal-to-oil consumed dropped from six-to-one (1918) to two-to-one (1930).

The demand for petroleum products began to outstrip petroleum production between 1900 and 1955. During this period, consumption expanded 70 times, while production expanded to 40 times above the 1900 level. After World War II, the increase in U.S. demand began to surpass domestic production, with the amount of net oil imports greater than the amount of net coal imports. The natural gas production rate also rose 40 times above the 1900 level by 1955. From 1900 to 1920 natural gas was mostly used for home and commercial purposes, but from 1920 until the end of World War II industrial consumption surpassed residential and commercial consumption. In 1955, the consumption of all liquid and gaseous fuels began to exceed domestic output. By 1955 the U.S. was a net importer of fossil fuels.

A new energy era was born on December 2, 1942, when the first nuclear chain reaction was demonstrated at the University of Chicago by Enrico Fermi and his associates. Less than 10 years later, electricity was produced from atomic energy. Today, approximately two percent of this nation's energy needs (almost 10 percent of our electricity) are provided by nuclear power.

Energy Resources from World War II until 1974

By the end of World War II, petroleum fuel consumption had caught up with coal consumption. From 1940 until 1971, crude oil consumption tripled and natural gas consumption increased more than eight-fold. Although oil and gas together accounted for approximately 70 percent of aggregate U.S. energy consumption in 1960, coal is still the preferred fuel in the production of ferrous metals and in the generation of electricity. Since 1960, the use of oil and natural gas has continued to grow. The following table shows the status of U.S. energy resources in 1974:

Energy Source	Percent of Energy
Petroleum	46%
Natural Gas	30
Coal	18
Nuclear	2
Hydro	4

Source: *National Energy Outlook*, p. xxii.

The total energy consumption in the U.S. has more than doubled since 1950 while the population has increased by approximately one-third. Two decades ago, this country was a net exporter of energy; in 1974 it was importing 15 percent of its total energy fuels and 35 percent of its oil.

The American Energy Crisis of 1973-1974: Background and Summary

Around 1954, the major American petroleum companies began to see their profits on crude production as well as their share of the international crude oil market start to decline. In 1960, the Organization of Petroleum Exporting Countries (OPEC) was formed. Initial membership consisted of five leading petroleum producers: Iraq, Iran, Kuwait, Saudi Arabia, and Venezuela. Their goals were to gain full control over the development of their oil resources and over the rate of oil production and the oil market price. OPEC's leverage was not strong in the 1960's but during the period from 1971 to 1973, OPEC members began to force oil prices upward. By 1973, 13 states in the Arab Middle East, Africa, Asia, and South America were members of OPEC and accounted for 86 percent of the

world's oil trade. During this period, a series of participatory agreements were negotiated by OPEC countries with companies operating within their borders. The situation changed, however, when the Arab-Israeli war broke out on October 6, 1973. Eleven days later, a conference of Arab oil ministers in Kuwait decided to use the "oil weapon" in support of the Arab cause. Petroleum-consuming countries were treated according to their stands on the Arab-Israeli issue. On October 19, King Faisal decided to impose an oil embargo when he learned that the U.S. government planned to send $2.5 billion in arms aid to Israel. A complete embargo was declared against the U.S. and the Netherlands; "friendly states" were exempted. Two months later, the OPEC governments were posting prices of $11.65/barrel for crude oil--almost four times the posted price that prevailed before the war began. The embargo ended with Americans waiting at the gasoline pumps, still in shock over the sudden realization of our growing dependence on foreign powers, but not yet truly convinced that anything could or should be done about it.

The international oil crisis of 1973-1974 precipitated an "energy crisis" for the U.S. and other industrial countries. The Arab (Middle East) countries, an important source of our petroleum products, suspended shipments of oil to the U.S. for several months. But the Arabs did not *cause* the "energy crisis"--they merely showed us that we have a serious energy problem. The roots of the problem go back to patterns of consumption and production of nonrenewable resources which began in the U.S. during the mid-nineteenth century.

APPLIANCE LIST

Appliance I used this week	Electrical Appliance	What this appliance did for me
	Air Conditioner, Central	
	Air Conditioner, Room Unit(s)	
	Battery Charger, Electric	
	Baby Bottle Warmer	
	Beanpot, Electric	
	Blanket, Electric	
	Blender	
	Broiler, Electric (Portable)	
	Broom, Electric	
	Can Opener, Electric	
	Coffee maker, Electric	
	Comb, Electric	
	Clock, Electric	
	Defroster for Refrigerator	
	Dehumidifier	
	Dishwasher	
	Disposer, Food Waste	
	Door Bell, Electric	
	Drill, Electric	
	Dryer, Clothing (Electric or gas)	
	Fan, Electric	
	Fingernail Buffer, Electric	
	Floor Waxer	
	Food Warmer Tray	
	Freezer (Independent Unit)	
	Fryer, Deep Fat, Electric	
	Frypan, Electric	
	Garage Door, Electric	
	Griddle, Electric	
	Grill, Outdoor Electric	
	Guitar, Electric	
	Hairbrush, Electric	
	Haircurlers, Electric	
	Hair Curling Iron, Electric	
	Hair Dryer, Standing or Portable	
	Heater, Room, Electric	
	Heating Pad	
	Hedge Trimmers, Electric	
	Hot Dog Cooker, Electric	
	Humidifier	
	Ice Cream Maker, Electric	
	Ice Crusher, Electric	
	Intercom	
	Iron, Regular or Steam	
	Kiln, Ceramic, Electric	
	Knife, Electric	
	Knife Sharpener, Electric	
	Lamp(s), Standard	
	Lamp, Heat	
	Lamp, Sun	
	Lawn Edger & Trimmer, Electric	

Appliance I used this week	Electrical Appliance	What this appliance did for me.
	Lawnmower, Electric	
	Lights, Indoor Night	
	Lights, Indoor Wall Fixtures	
	Lights, Outdoor Lawn	
	Manicure Set	
	Massager, Electric	
	Mathematical Calculator	
	Mirror, Lighted, for Make-up	
	Mixer, Electric	
	Oven, Bun or Roll Warmer	
	Oven, Portable	
	Oven, Toaster	
	Pencil Sharpener, Electric	
	Popcorn, Popper, Electric	
	Projector, Movie	
	Projector, Slide	
	Radio, Clock	
	Radio, Standard	
	Range, Kitchen, Electric	
	Razor, Electric	
	Record Player	
	Refrigerator	
	Rotisserie	
	Router, Electric (Tool)	
	Rug Shampooer	
	Sander, Electric	
	Saw, Electric	
	Scissors, Electric	
	Sewing Machine	
	Shoe Polisher, Electric	
	Soldering Kit, Electric	
	Tape Recorder, Electric	
	Television	
	Thermostrat (Oil or Gas Heat)	
	Toaster	
	Toothbrush, Electric	
	Train Set, Electric	
	Typewriter, Electric	
	Vacuum Cleaner	
	Vaporizer	
	Waffle Iron	
	Washer, Clothes	
	Water Heater (Electric or Gas)	
	Water Pik	
	Woodburning Set, Electric	
	Yogurt Maker, Electric	
	Other (List)	

ENERGY AWARENESS

Directions: The following question are to be asked by the teacher. The students will respond by answering yes, no, or pass when called upon. If the student does not know the answer, instruct him/her to respond with the word "pass."

Questions	Answers
1. There is an energy shortage	yes or no
2. The sun is an energy source.	yes
3. The wind is an energy source.	yes
4. I watch how much energy I use around home.	yes or no
5. A tree is a renewable resource since it only takes about ten years to grow some trees.	yes (example: popular, cottonwood)
6. Coal and oil are non-renewable energy sources, since it takes millions of years for them to develop.	yes
7. Energy cannot be created and it cannot be destroyed.	yes
8. We really use a lot of geothermal energy in the United States.	no
9. Pollutants can result from burning coal.	yes
10. Do you believe the future is positive in terms of energy?	yes or no

A high number of incorrect and/or "pass" responses indicates the need for review of basic energy facts.

ENERGY FACTS

It is necessary to review basic scientific facts. Respond to the following questions using the handouts provided.

1. Energy and the Laws That Govern Its Use
   a. Define kinetic and potential energy

   b. What are the First and Second Laws of Thermodynamics?

   c. Describe the influence the knowledge of these laws should have on each of us as consumers of energy.

2. Energy Sources
   a. List the primary energy sources.
   Identify each source as continuous or nonrenewable.

   b. Why is it important to know whether the energy source is continuous or non renewable?

3. Conversion of Energy and the Uses of Energy
   a. Describe one example of using an energy source in its original (primary) form.

   b. Define conversion as related to energy sources.

Question 3 continued

c. What are the end uses that are made of energy?

4. Energy Consumption Pattern of the U.S.A.

a. The United States presently depends on which primary energy source?

b. Describe the present consumption pattern of energy resources.

c. Where does the problem exist in our present consumption pattern in terms of the resources we have available in the environment?

d. What energy sources are used in your home?

5. Reasons For Energy Conservation

a. What are the reasons for energy conservation cited in the publication entitled "How Much Energy Can Be Saved by Recycling"?

b. What are 4 negative effects that energy use has on the environment?

What It Is, What It Does[22]

"A rose is a rose is a rose" is a definition of a rose only to someone who has seen these flowers. We can do little better in talking about energy; we can only define it to someone who already has some idea of what it is.

There are, of course, scientific statements we could make about energy, about its relation to such other scientific concepts as force, work, and power, or about the laws that govern it. We will, however, take a bare minimum of words from the vocabulary of science, only those needed to understand the twin crises of energy and environment. We will begin the story with "energy is energy."

Energy Is

It is not possible to be unaware of energy; it forces itself to our attention from all parts of our life. Newspapers and magazines carry articles about the Energy Crisis and the ways we are moving to meet it. Television carries advertisements about oil exploration and documentaries about strip mining on the Western Plains. There is an image of energy in the smoke from a power plant or a steel mill, in the transmission lines along the road or the oil truck on it. There is energy in the electric toaster and in its hot buttered toast. Energy is defined to us in all these ways and many more.

> *Whenever we have heat, or light (or the other forms of radiation: radio, x-rays, ultraviolet, etc.), or motion, we have energy in action. Whenever we have something, such as a lump of coal, a battery, or a piece of uranium, that can ultimately provide us with heat, light, or motion, we know that energy is stored in that something.*

When faced with such diversity, our first step toward understanding is to set up categories, to reduce the diversity of form that energy shows by classifying it. We have already suggested the first classification. Energy in the form of motion, heat, or light is called *kinetic energy*. The energy stored in bread, gasoline, or batteries, in the nucleus of the uranium atom, or in any of its other clever hiding places, is *potential energy*. Kinetic energy is energy in transit, energy on the move. We *use* it in this form. Potential energy is *stored* energy and it is in this form that we dig it from mines, pump if from wells, ship it, and stockpile it. The whole story of energy is found in the description of these two forms, and in the conversions between them.

To *use* energy it must be in the kinetic form. We use energy because we want to *do* something to matter: move it, illuminate it, or warm it. A moving car has kinetic energy. The electrons flowing through the toaster's heating element and the photos of light coming to us from the sun have their energy in kinetic form.

We *store* energy in the potential form. It is, of course, possible to store kinetic energy; the flywheel of an engine stores kinetic energy in its rotating mass and kinetic energy is stored in the rotation of the moon about the earth. We can, also, store heat energy in Thermos bottles. Light energy is almost impossible to store. Kinetic energy storage, however, is quite different from potential energy storage. It is temporary; we trap or insulate kinetic energy, it is a caged tiger ready to run free.

Potential energy storage is more permanent. It is accomplished within the structure of matter. Energy is stored, for instance; in the carbon atom and released when that carbon atom is combined with an oxygen molecule in the chemical reaction we call burning. The product of this reaction is carbon dioxide, CO_2. The nucleus of the uranium atom stores energy that is released when that nucleus is split in two in the fission reaction. A simple way to store energy is to lift something away from the earth. Energy is stored when water is pumped to the top of a water tower, then converted to the kinetic energy of motion when the water is allowed to run through the pipes to its final destination. In general, to store energy we must move things around against the action of some force, lift a weight, force electrons into a battery or compress a spring, for instance.

The Energy Laws

From what we have said so far, it should be becoming clear that the story of energy is one of flow and change. Energy is not really like a flower, but like a chameleon; it has a basic identity but constantly changes form. It can be potential energy stored in coal, but when the coal is burned in a power plant furnace, it changes to a kinetic form, the heat energy of steam. When the steam is allowed to strike the blades of a turbine, some of this heat energy becomes the kinetic energy of motion of this engine. The turbine turns an electric generator and some of the same energy that was released from the coal becomes electric energy, the kinetic energy of the motion of electrons in wires. And still the flow doesn't end; electricity goes out through the wires to perform a great variety of tasks, from running the turntable of our stereo to making ice cubes in the refrigerator.

These changes of form are not free or arbitrary, they are governed by strict laws. The first of these is quite reassuring; it seems to say that there can't be an Energy Crisis. Called the Law of Conservation of Energy (or the First Law of Thermodynamics, if you want a fancy name) it states:

> *Energy can be neither created nor destroyed.*

This says that once you have a certain amount of energy, the 200 Calories you get from eating a candy bar, for instance, it never disappears. It may become heat energy in your body, or power your muscles, or be used in the processes in your brain. It may be stored as fat. More likely, it does some of all these things all at once, but it always remain 200 Calories of energy.

This first law is good news. We can never run out of energy. Where then is the problem? The second law, which is named "The Second Law of Thermodynamics," but which we'll call "The Heat Tax," gives the bad news:

> *In any conversion of energy from one form to another some of it becomes unavailable for future use.*

It becomes unavailable because it becomes heat and it is not possible to convert a given amount of heat energy completely back into another form. Said in another way, in any conversion or use of energy there is a "heat tax"; some of the energy becomes heat and is no longer usable. This unusable heat energy leaks away and gradually warms up the earth (and finally the universe). It is this second law that is behind the Energy Crisis.

It is also clear that this second law puts heat energy in a unique position. It is possible to convert all of a certain amount of mechanical energy to heat, by rubbing two sticks together or putting on the brakes of a car, for instance. It is possible to convert all the chemical energy of coal into heat energy by burning it. These conversions cannot go to completion in the other direction, however. In the language of science they are "irreversible." Heat energy stands at the end of a one-way street, all other energy forms ultimately can be converted into heat, but only a limited amount of heat energy is convertible back to other forms.

Where Does the Energy We Use Come From 21

Primary Energy Sources

There are five *primary* sources of energy that are naturally available to us on earth: solar, chemical, nuclear, geothermal, and tidal energy. Two of these, the chemical enegy of fossil fuels and nuclear energy are *stored or potential* forms of energy. The other three — solar, geothermal, and tidal energy — are *kinetic* forms of energy; that is forms which are active and always in motion. While we can use the energy in the stored sources of energy whenever we choose, we can use the kinetic forms only when nature makes them available to us; for example, sunlight is only available during daylight hours. In the sections that follow we will briefly discuss each of the primary sources.

Solar energy: Solar energy is a kinetic form of energy. It is more precisely called radiant energy, much of which is observable as visible light. A major portion of the sunlight which approaches earth is reflected by the atmosphere back into space. Although only roughly half of the solar energy reaches the ground, half is still a tremendous amount. If all the solar energy reaching the ground could be stored for 48 minutes, it could provide as much energy as used worldwide in 1970.

A very small part (1/5000) of this energy interacts with plants and fuels the photosynthesis process. Solar energy, thus, is indirectly the source of the food energy on which we depend. It is also the source of the chemical energy which was stored hundreds of millions of years ago in the plant life of the swampy jungles of earth. We are using stored solar energy when we burn the fossil fuels; coal, oil, and natural gas.

The sun's radiant energy also heats the land and the oceans and thus provides the energy for the great air and ocean currents — the winds and waves. Historically, wind and water currents were early sources of energy and were harnessed by windmills, sailboats, and waterwheels. With increases in the world's population and the rise of cites, however, these sources became inadequate. Today we get some of our energy from these wind and water currents in a different manner. Some of the sun's energy evaporates water from lakes and oceans. The water rises and is carried in the winds. If the water falls on the mountains, we get some of the energy for our use by letting the mountain-fed streams and rivers turn the turbines of hydroelectric plants to produce electricity.

Most of the solar energy reaching the ground is unused by man. It is available during the daylight hours throughout the world in varying amounts. However, since it is a kinetic form of energy, it must be used immediately or it must be converted into some potential form of energy for later use. Presently, sunlight is being used as the sole source of heat for a few homes. However, collection and storage of solar energy for later transportation and use is still difficult. In particular, we have not perfected practical and economical methods of collecting solar energy and converting it into electricity. Since the lifetime of the sun is many billions of years, for all practical purposes this energy source will always be with us. It is a *continuous* source of energy which does not need to be renewed.

Fossil fuels: The most important form of stored energy is the chemical potential energy of the fossil fuels; coal, oil, and natural gas. As we have said, this energy was originally solar energy hundreds of millions of years ago. Coal began to be formed when the huge mosses and ferns of the Paleozoic swamps died and fell into the mud. They were acted on by anaerobic bacteria (bacteria which don't need oxygen) and then by pressure and heat as they were buried under tons of sediment and converted to the almost pure carbon of coal. When the carbon atom is burned (oxidized), it releases this stored energy.

Petroleum and natural gas were formed in a similar manner. Some of the plant and animal life sank to the bottom of the great sea beds and went through a different chemical transformation under pressure and heat to form the "hydrocarbons," the complicated molecules of hydrogen and carbon characteristic of petroleum. Their stored energy is also released by burning.

Fossil fuels are used extensively because they are relatively easy to find, collect, store, and transport. Coal, oil, and natural gas resources can be located through geological surveys. Once discovered, the fuels can be removed from the ground by mining or

drilling and transported by pipes, truck, rail, etc. to any destination. Although the formation of fossil fuels is continuing, the process is very slow. It would take another 300 million years or so to produce an amount equal to that which has been built up so far. Since our energy use is much more rapid than this, we are likely to use up all of our fossil fuels. For this reason, fossil fuels are called *non-renewable* sources of energy.

Nuclear energy: A form of potential energy which is of growing importance is that stored in nuclei, the tiny, dense cores of atoms. Nuclei are made up of the elementary particles – protons and neutrons. It is by rearranging these particles that nuclear energy is stored and released. There are two important examples of this: the fission reaction and the fusion reaction. In the fission reaction, the heavy nucleus, or center, of an atom such as uranium is split into two lighter ones. In this process, mass is converted into energy and it is this energy we obtain from the hot interior of a nuclear reactor.

The fusion reaction involves very light nuclei. It is the same reaction which is the source of the sun's energy. In a typical example, four hydrogen nuclei, by a complicated series of reactions, combine to form the heavier helium necleus (two protons and two neutrons). Again, some of the mass has been converted to energy.

Nuclear energy becomes available to us in the nuclear reactor of an electric power plant. The energy of the neclear reaction heats water, for example and converts it to steam. This turns a turbine which produces electricity much as a river is used in a hydroelectric power plant. The electricity is then transmitted to our homes through wires. The major fuel for the fission reaction in nuclear reactors is Uranium 235; it is available in limited quantities throughout the world.

Like the fossil fuels, the nuclear fuels are also presently *non-renewable.* However, if all of the many technical and safety problems of a new type of reactor called the breeder reactor can be overcome, nuclear fuels will be much more plentiful. The breeder reactor, while it uses up some nuclear fuel to produce electricity, produces a by-product which can be reused as a nuclear fuel to produce more electricity.

Geothermal energy: The earth's interior is molten rock, or "magma" as the geologists call it. There is a tremendous amount of energy in the earth. Although heat energy is an active or kinetic form of energy, the heat of the earth is effectively stored and insulated by the solid, thin crust on which we live.

We are not sure how the energy got there. It may have been stored in the molten blob of original earth, or it may have come from the impact of countless chunks of matter pulled to it by the earth's gravity. We are fairly certain that the radioactivity of some of the material in the earth keeps it hot. There seems to be enough uranium, radium, and other naturally radioactive material in the earth's interior to produce that relatively small amount of heat needed to make up for that lost through the surface. In this sense, geothermal energy does not need to be renewed and is essentially a *continuous* source.

The geological conditions which produce geothermal energy restrict this energy source to a few geographic areas. Where available, it is inexpensive, clean, and has few adverse environmental effects. It is available to us in those regions where the magma is close to the surface and the energy can leak out from the core through cracks in the crust. Volcanoes, geysers and hot springs are visible evidence of geothermal reservoirs, but more sophisticated techniques will soon allow us to find others not evident on the earth's surface. If available as hot water or steam, geothermal energy can be used to heat buildings. Some 500 homes and offices in Klamath Falls, Oregon, are heated by hot water drawn from a hot spring running under the town. The only large-scale use of it is in The Geysers in California where dry steam – steam so not there are no water droplets in it – is piped to steam turbines and used to generate electricity.

Tidal energy: The last of the big five, tidal energy, is probably of least importance of our use. The source of this energy is the kinetic energy stored in the rotation of the earth-moon system. Like geothermal energy, it is another example of the successful temporary storage of energy in the kinetic form. It is *continuous* and does not need to be renewed. This energy is converted to motion of the oceans through the gravitational attraction of the moon on the oceans' contents. Ocean water is pulled toward the moon on the near side (and bulges in the other direction on the far side). To use

this tidal energy, the up and down (in and out) motion of the water must be used to turn a turbine and produce electricity. This electricity can then be carried by wires to homes and offices.

Tidal generation of electricity is only practical where geologic peculiarities cause high tides. The first tidal dam and generator were built in the Rance estuary on France's Brittany coast where tides rise and fall an average of 26 feet.

There has also been some interest in building a tidal conversion facility at Passamaquoddy Bay on the far northern coast of Maine, but it does not yet appear commercially usable. We do not expect much contribution to our total supply of energy form this form.

The Flow of Energy[22]

Consumption by Conversion

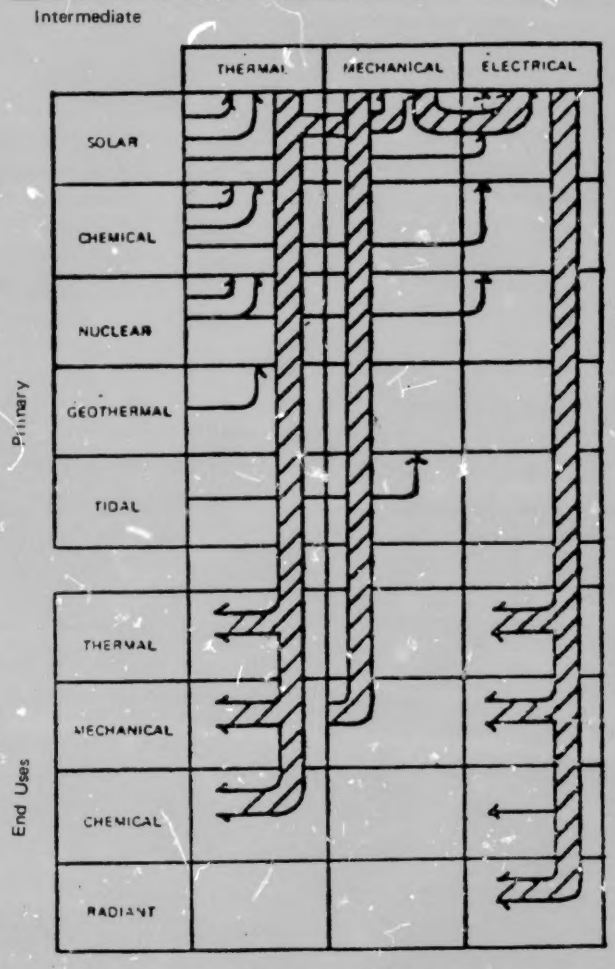
A sailboat sailing gracefully in the wind and a waterwheel grinding corn are among the few remaining examples in our complex industrial society of energy being used in its original form. In almost all other cases when we speak of "using" energy, we are really talking about converting it from one form to another. Energy is not consumed in our system, it flows through it, with only the absolute amount (the total Calories) remaining (as the first law tell us) the same.

We symbolize this flow in a crude way by Figure 3-1. We classify energy in three different ways: as primary sources, as intermediate forms and as end uses. Figure 3-1 is not a precise diagram; thermal energy, for instance, is an end use in home heating or steel-making, but an intermediate form in the automobile engine.

As we have said, the primary sources occur both as kinetic and potential energy; solar, geothermal, and tidal are kinetic, while chemical and nuclear are potential. The intermediate forms are all kinetic, they are energy in transit from one form to another. Electric energy is the prototype intermediate form; it must always be converted to be useful to man.

The end uses, as were the sources, are split between kinetic and potential types. When we use energy to produce work, light (or other forms of radiant energy) or heat, we are using kinetic energy. A significant amount of the energy expended in the industrial sector goes into the rearranging of molecules and thus into chemical potential energy. Some of the energy used in refining raw materials is stored in this way; plastics manufacture is an example. This stored energy is then released when plastics burn or metals rust.

FIGURE 3-1
Paths of Energy Conversion



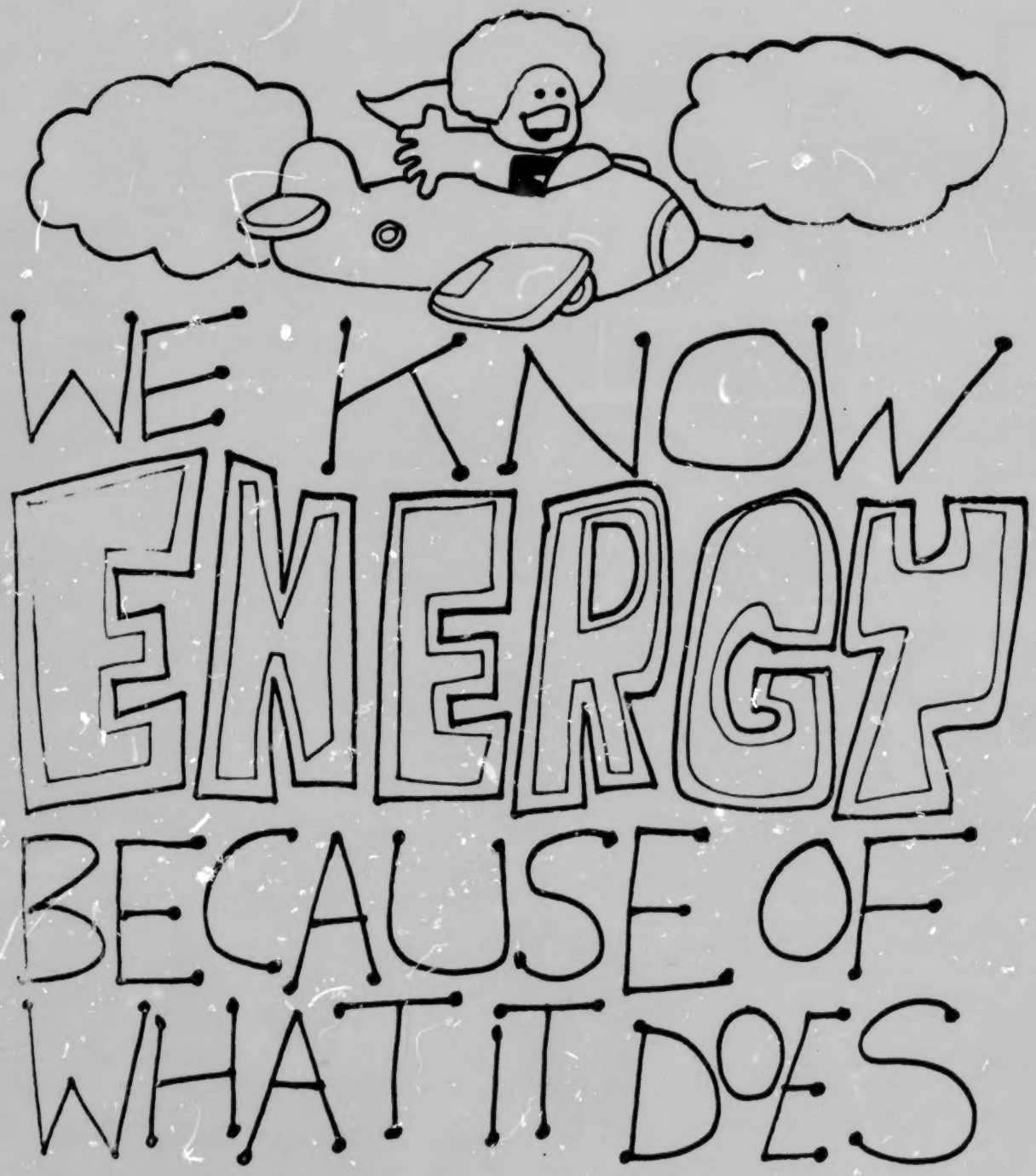
Legend: The smaller lines indicate relatively unimportant conversions

For a further understanding of the conversion of energy, see supplement 8.

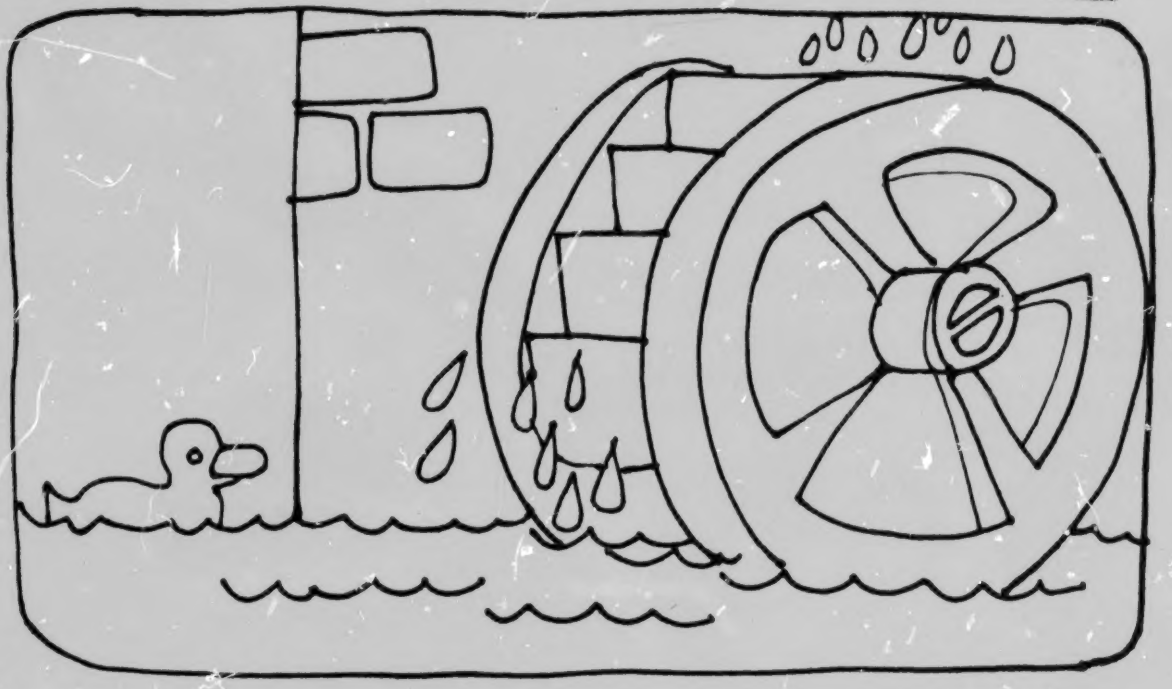
ENERGY CONVERSIONS[21]

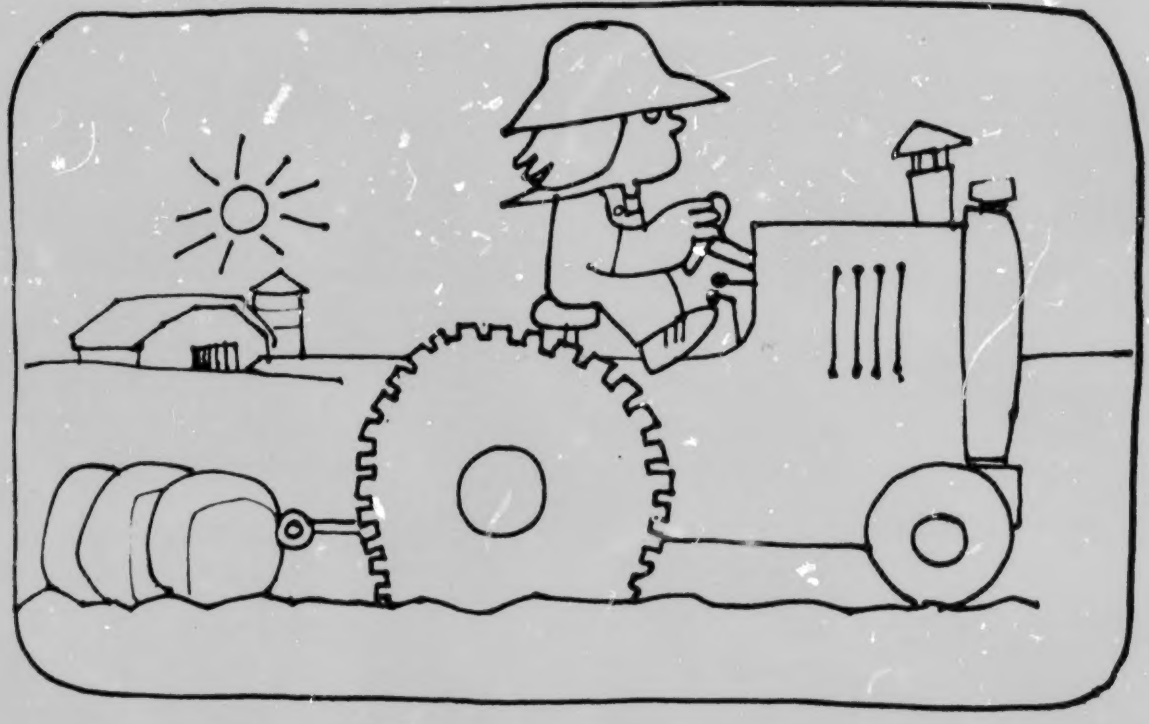
Activity	How do I know Energy was Being Used	Immediate Energy Source	Primary Energy Source
people exercising	motion, warmth	food	(solar energy)
fan On	motion	electricity	(fossil fuel)
light bulb On	light, warmth	electricity	(fossil fuel)
candle burning	light, warmth	candle wax	(fossil fuel)
radiometer near candle	motion	candle or sun	(fossil fuel or solar energy)
car at 30 mph	motion	gasoline	(fossil fuel)
hamburger cooking on grill	getting warm	charcoal	(solar)
clothes being washed in washing machine	motion	electricity	(fossil fuel)
stove or oven heating	heat	gas or electricity	(fossil fuel)
television playing	light	electricity	(fossil fuel or solar)
geyser erupting	heat, motion	geothermal	geothermal
person riding bicycle	motion	food	solar

We Know Energy By[21]
What It Does

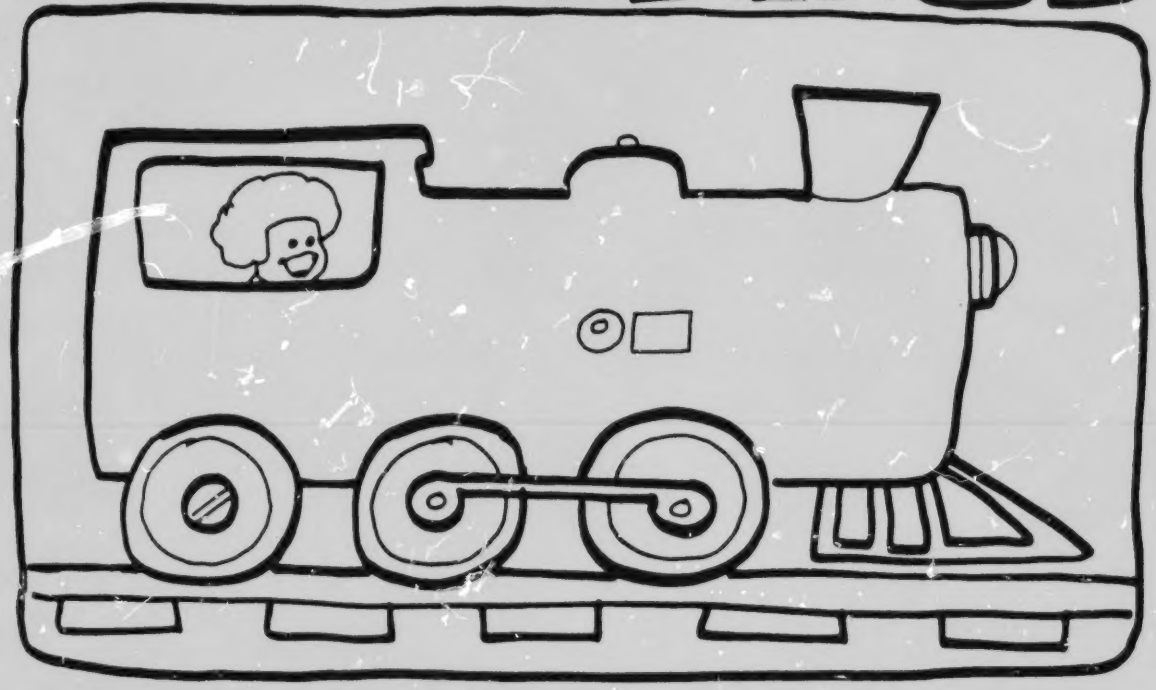


ENERGY





moves things



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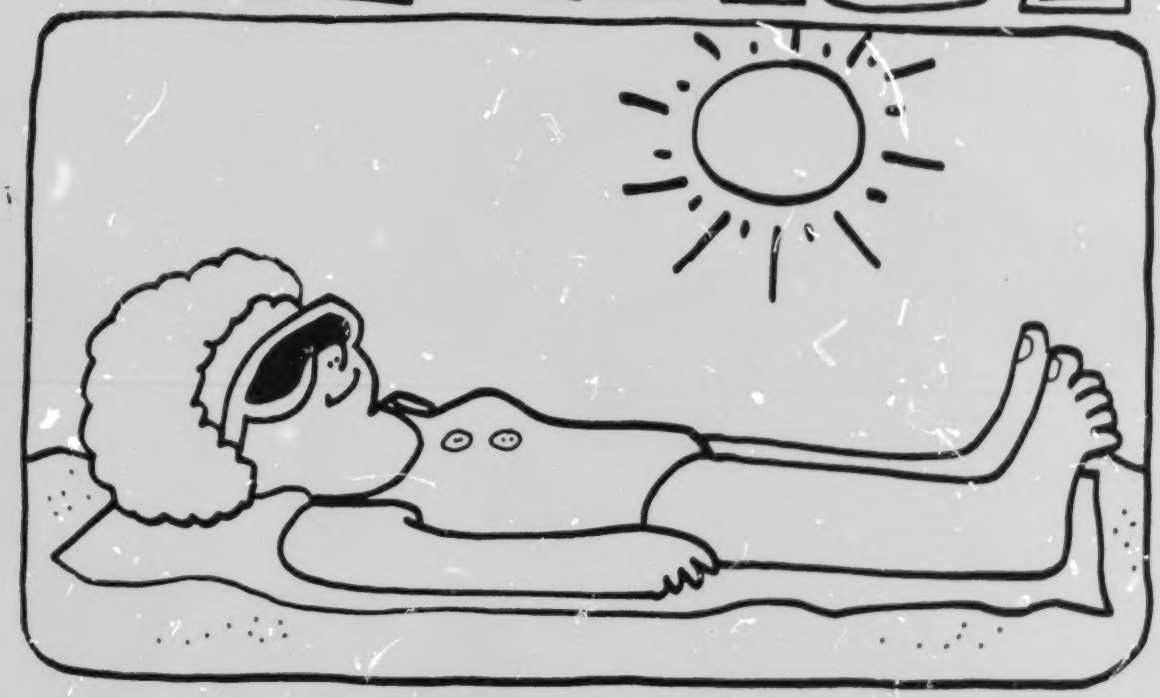
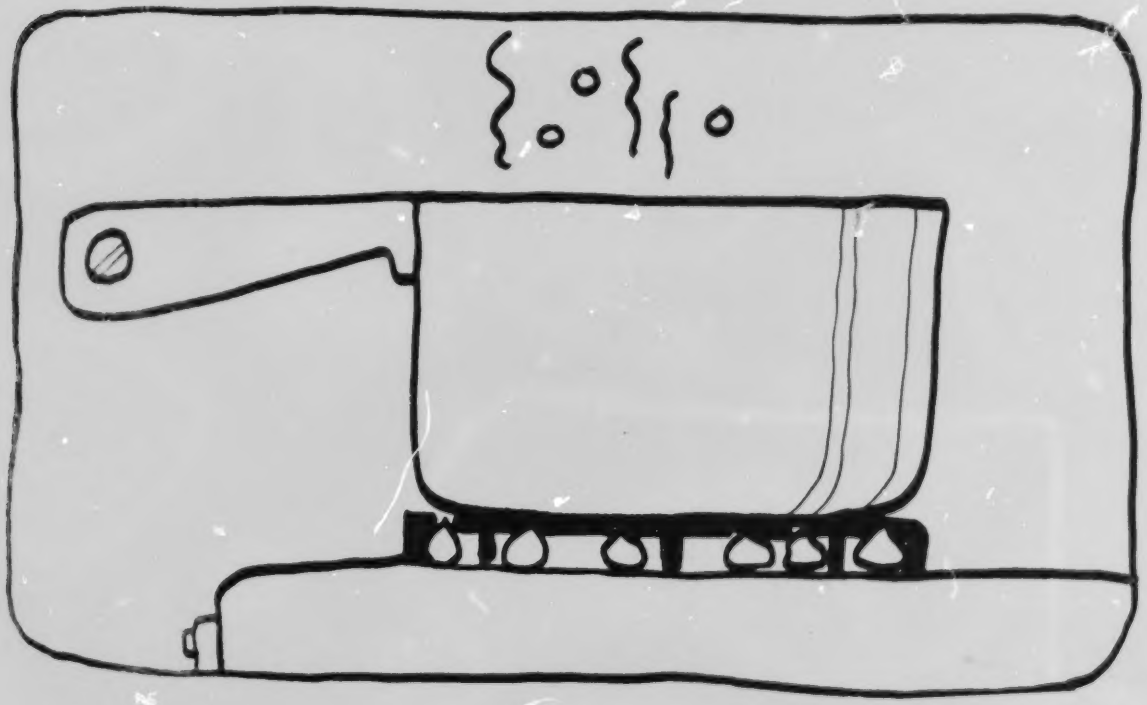
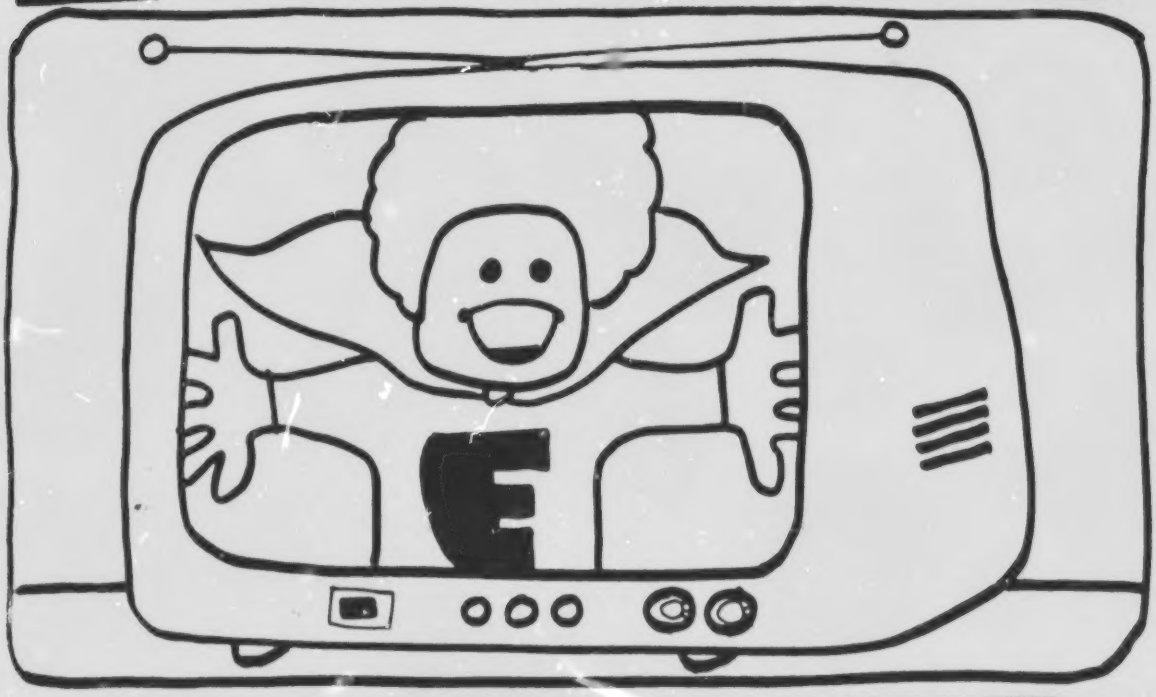
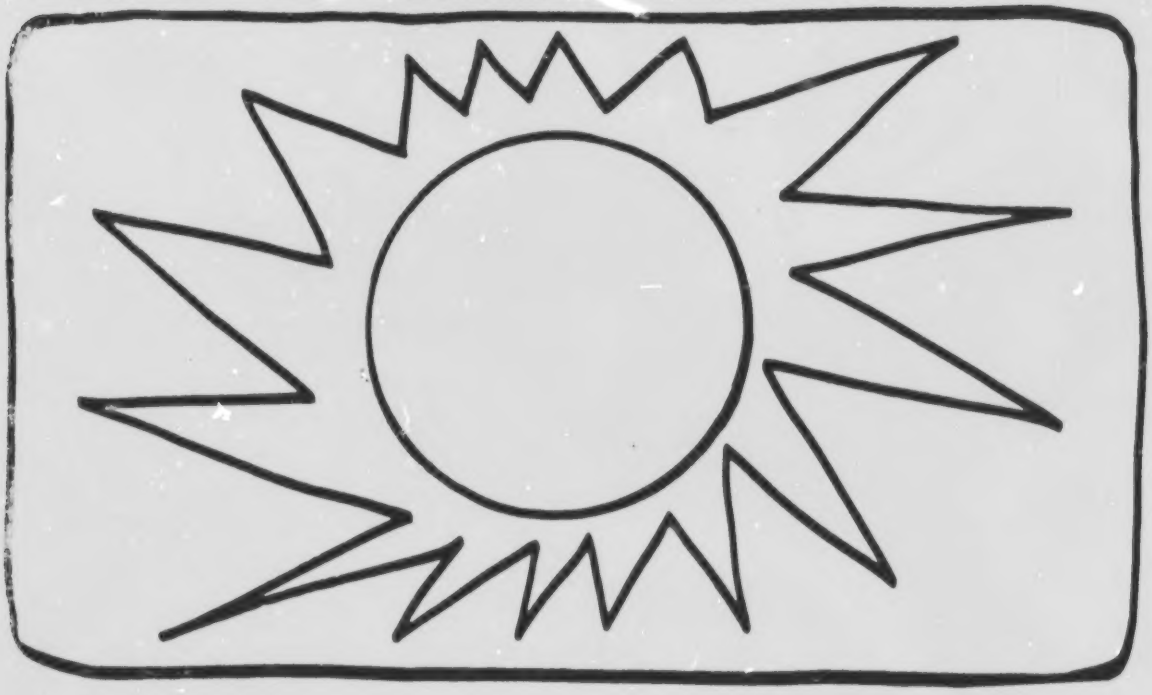




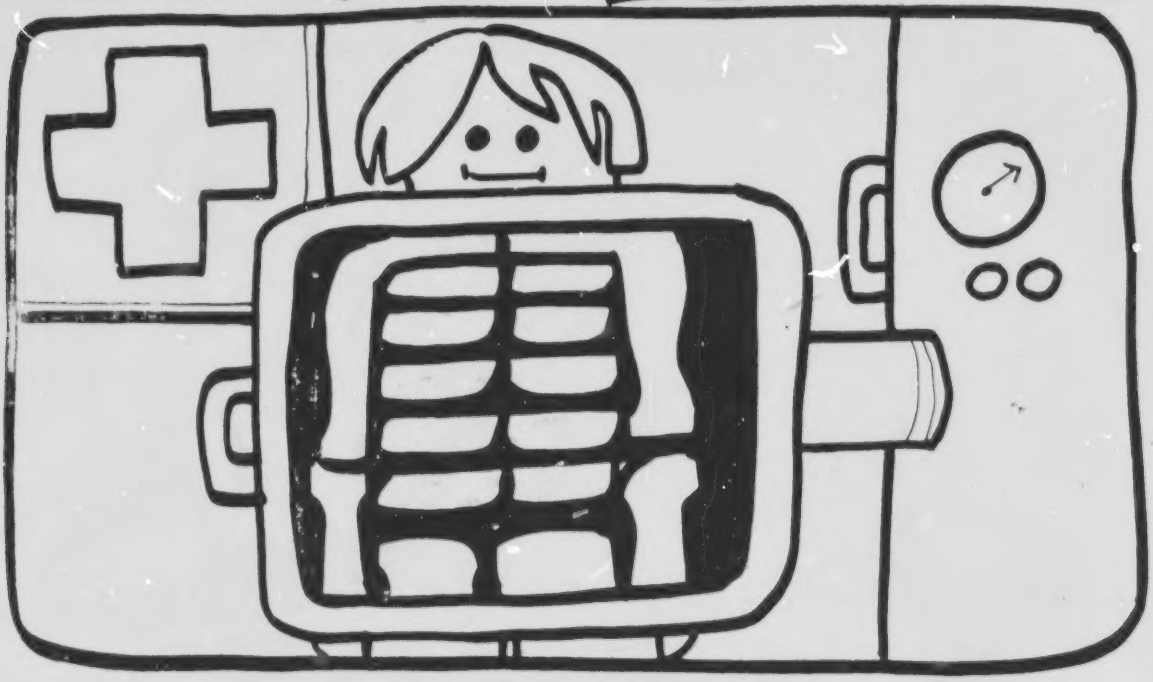
heats things

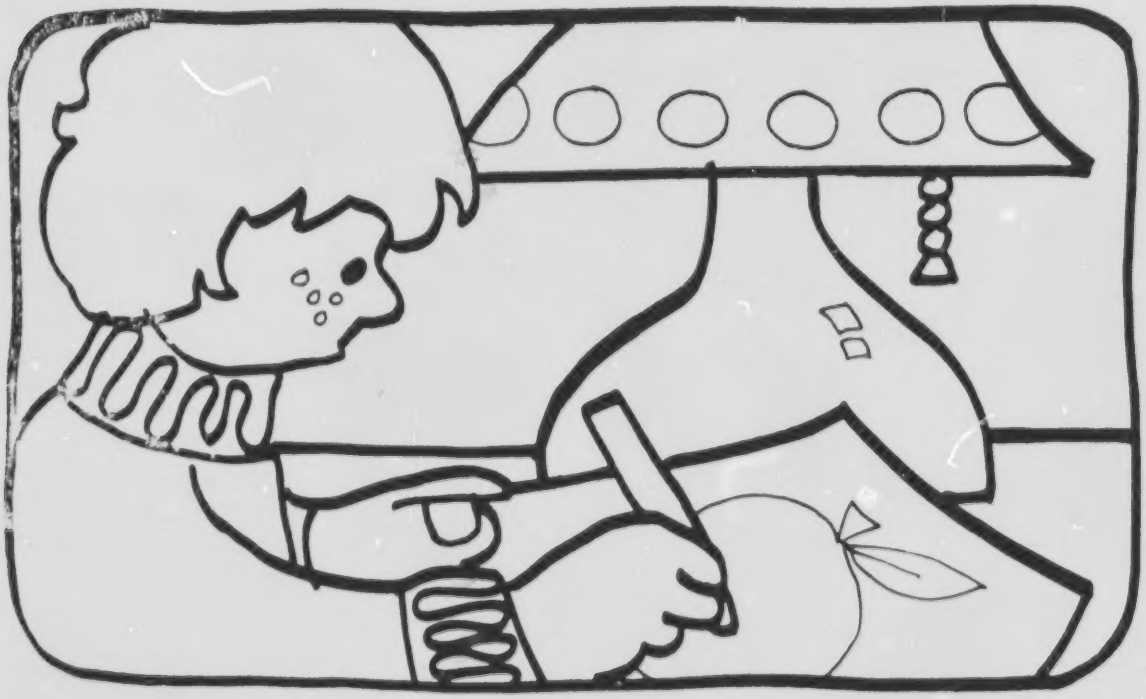
ENERGY





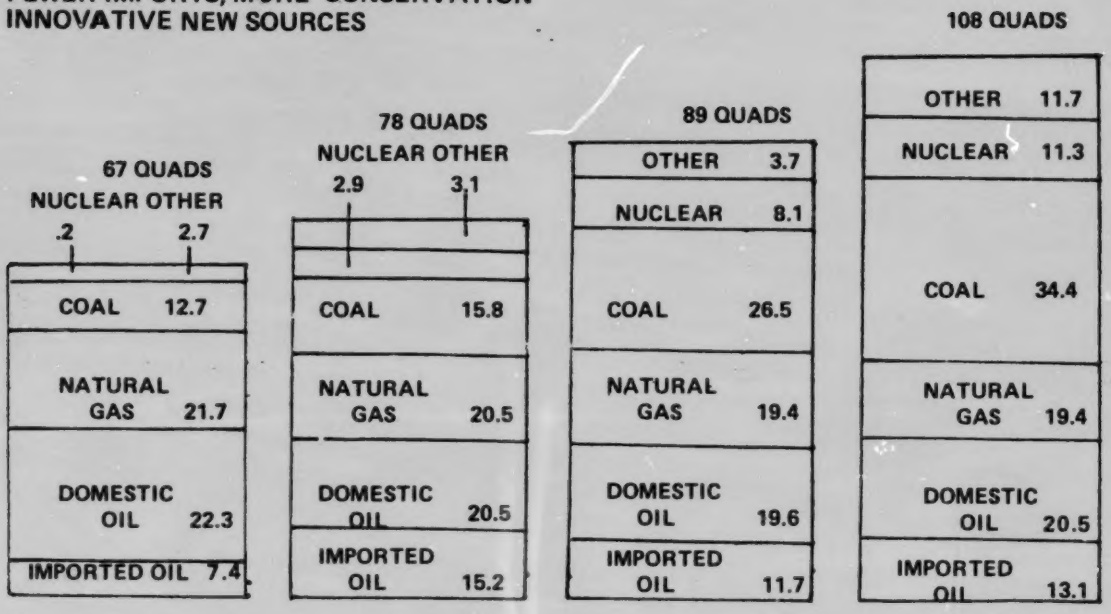
lights things





Energy Consumption Patterns in America[19]

FEWER IMPORTS, MORE CONSERVATION INNOVATIVE NEW SOURCES



Oil in the United States was plentiful and cheap. In 1970 imports cost about 3 billion dollars. Despite the 1973 Arab oil embargo and subsequent soaring prices, the U. S. more than doubled oil imports in the 70s.

By 1979 the U. S. oil import bill had jumped to 60 billion dollars and energy use peaked at 79 quadrillion Btus. In 1980 consumption declined, reflecting conservation and recession.

In the '80s oil imports will be constrained, domestic production encouraged by price decontrol, and power plants will convert to coal. Prices and government actions will result in more fuel-efficient cars and homes.

The economy will likely shift from oil and natural gas to coal, nuclear, and synthetics. Coal will become the nation's primary energy source, though nuclear may become the major producer of electricity.

DATA AND INTERPRETATION BASED ON ENERGY INFORMATION ADMINISTRATION PROJECTIONS

HOW MUCH ENERGY CAN BE CONSERVED BY RECYCLING?[12]

New aluminum used 20 times as much energy as recycled aluminum.
New paper used twice as much energy as recycled paper.
Artificial fabrics use 10 times as much energy as natural fabrics.

Energy Conservation

Energy Conservation Saves Our Resources

For years we have used energy as if we would always have as much as we could ever need. Scientists and engineers always seemed able to find new sources of energy, new ways to make it cheaper, and new ways to use it to make life more pleasant.

Not only has the amount of energy each person uses grown over the years, but the number of people using energy has also grown. In 1900 there were 75 million people in the United States and each person used 100 million BTU's of energy. Today, there are over 211 million Americans, each using 300 million BTU's of energy. At this rate, all our energy supplies will soon be gone. Already we can estimate how long our fossil fuels will last.

Coal is by far our largest fossil fuel resource. At current rates of use, the United States has more than a 500-year supply. However, as our available petroleum and natural gas reserve are used up, we can expect coal to be used at even faster rates in the future. Coal may then be substituted for oil and natural gas. If this happens, then our coal supply may run out much sooner than expected.

Of course, some new oil and natural gas may be discovered which could extend the time before all our fossil fuels are gone. But only by conserving energy – by using less and stretching out our remaining supplies – can we really count on having the time we need to develop new energy sources in the form of solar, geothermal, and nuclear power.

A lot of energy is used by industry to process and manufacture the many things we buy. Generally, products made from used or recycled materials take less energy to make than do products made from new materials. For example, it takes only about 25 percent of the energy to make steel from scrap steel as it does to use iron ore; for aluminum, the figure is less than 5 percent; for copper, 5 to 10 percent; and for paper, 60 to 70 percent.

In the same way, throwaway bottles and cans represent wasted energy, as well as wasted materials. Usually, returnable containers for beverages need only one-fourth as much energy as one-way bottles and cans.

A Project To Do: Recycling

You can help conserve our supplies of energy by supporting your local recycling center.

At home, separate into different containers clear glass, green glass, amber glass, aluminum, and other metals. Find the nearest

recycling centers for each material and be sure your collections are taken there.

Energy Conservation Protects The Environment

The more energy we use, the more we pollute our environment. This happens in a number of ways. The exhaust fumes from automobile engines are the source of 60 percent of the air pollution throughout the United States. Even small amounts of these gases can injure plant life and human health. Sometimes sunlight and weather will interact with auto exhaust to produce a condition we call ''smog.'' Smog is highly irritating and can cause problems in breathing. It can even contribute to the deaths of persons already weakened by age or illness.

Production of oil can also endanger the environment. The nature of the hazard depends on whether theoil is drilled on land or offshore. Wells drilled on land can have a bad effect on the air, the water, and the land itself. Pollution of the land and nearby water can result from oil spills, ''blowouts'' (uncontrolled oil gushers), and salty waters that come from the well.

Risks connected with offshore wells include accidental spills and leaks from the oil source. Oil can kill ocean plants and animals, or it can spoil the flesh of fish and shellfish and make them unfit to eat. Many nations depend on food from the sea in addition, massive offshore oil spills can pollute beaches and marshes, destroying recreational areas and wildlife nesting grounds.

We are familiar with the ''smoke'' that is given off by burning coal oil or wood. This smoke is a kind of air pollution. Fewer homes today have coal furnaces than was true 20 years ago. Coal for home heating has been largely replaced by oil, electricity, and natural gas - partly because they are cleaner, and also because they are more convenient. But waht this often means is that although less coal is burned to heat individual homes, great amounts must now be burned in powerplants to generate electricity.

Electric utilities in recent years have spent large sums of money to ''clean up'' the smoke caused by burning coal to produce electricity. Complex equipment can remove particles of ''soot'' as well as unhealthy gases that are given off by burning coal. However, cleaning up coal smoke is very expensive and besides small amounts of soot and gas can still escape up the stack and contribute to air pollution.

Not only does burning coal cause air pollution, but the process of extracting coal from the earth can cause water pollution and result in great damage to the land. During surface or strip mining, large areas of forested or fertile land my be destroyed to get at the coal lying underneath. And, in tunnel mines, underground water sources are disturbed, causing water to seep through the mines, picking up unwanted acids. This acid mine drainage pollutes rivers, killing fish and water plants.

While nuclear power stations do not pollute the air, they do produce poisonous radioactive waste materials. This ''atomic trash'' will remain radioactive and highly dangerous for periods of 25,000 years or even longer. At present, there is no completely safe way to dispose of the radioactive waste from nuclear powerplants. Instead, the waste is placed in special containers and is ''stored'' on a permanent basis, guarded and watched over by the Federal Government. Although no serious pollution of the environment from reactor wastes has occured, there have been spills and leakages of stored wastes. The problem of handling and storing nuclear wastes power is generated from nuclear reactors and more wastes are produced.

Another form of pollution is from waste heat from powerplants. Too much heat introduced into a stream or river can kill fish and plants found

there just as surely as acid mine drainage, untreated sewage, or chemical wastes. Electric powerplants cluding coal-fired plants and those that use nuclear fuel, require large amounts of water for cooling purposes. Many utility companies have built "cooling towers" designed to release most of the heat from the cooling water into the air by evaporation. Water at lowered temperatures is then returned to the river, effectively reducing thermal pollution. But cooling towers are expensive and, in the case of plants situated in desert areas (some of the Western States), the water that is evaporated may be badly needed for irrigation.

Air and thermal pollution, acid mine drainage, and damaged landscapes - these are some of the costs of the energy we use. Expensive equipment can help reduce environmental harm - but there is another way, too. By using only the energy we really need we can help keep the enviornment clean and livable.

Another very important reason for saving energy is the money you can save. Savings, of course, are important for yourself and your family. But savings in the amount you pay for energy will help your country as well.

During pericds of inflation the costs of almost all goods and services rise at an abnormal rate. Everyone finds that his dollars buy less - and this can mean serious hardship for many. Inflation is especially hard on people with lower incomes, and elderly people living on fixed incomes, such as Social Security.

One of the reasons for rising prices is an imbalance between the supply and demand for goods and services. When something is scarce and desired by many, prices tend to rise. By using less energy, we can make the supply of energy more nearly match the demand, and energy prices will tend to remain more stable. Thus, saving energy can make the supply of energy more stable. Thus, saving energy can help hold down inflation.

By using less energy you will also help hold down the amount of energy - mostly petroleum - that we must buy from other countries. You know that an individual cannot afford to spend more than he earns over a long period of time. The United States cannot, in the long run, afford to purchase more from foreign countries than we earn from the goods we sell abroad. By helping hold down the amount of energy we must import, you are helping us maintain a healthy balance in our trade with other nations.

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ENERGY CONSUMPTION CONTINUUM

This game is a graphic demonstration of students' stand on energy usage.

Preparation:

Teacher make two signs "Saving Sally" and "Energy User Eddie", and place on opposite sides of the room. Explain the meaning of each sign:

1) Saving Sally – won't even use the toaster = 0

2) Energy User Eddie – wants the thermostate on 80° in the winter and takes at least two long showers a day for about 30 minutes each.

Directions:

Ask students to stand along an imaginary line at the point they feel their reaction would be to the extreme views of energy use. The teacher should take a stand also. Students may react verbally instead of standing; however, actually standing may encourage students to express their energy-use values more strongly.

Discuss why students selected their positions along the continuum. Encourage students to choose a number between 0 and 100 to describe their stand on energy usage.

FAMILIY LIFESTYLES DISCUSSION GUIDE[26]

Question:

What are some differences in the television family lifestyles that are related to energy use including:

a) means of travel

b) how they obtain food

c) type of work

d) how they spend recreation time

e) clothing selected

f) their housing

ACTIVITY X LIFESTYLE INDEX [26]

OBJECTIVE: TO AID THE STUDENTS IN UNDERSTANDING THEIR LIFESTYLES IN TERMS OF ENERGY REQUIREMENTS AND TO PLACE THEIR LIFESTYLES IN WORLD PERSPECTIVE.

The Lifestyle Index is designed to demonstrate how much energy an individual uses each year and how his standard of living compared with that of an average individual in other countries of the world.

The basic unit employed is the Energy Unit which is equivalent to about 10 kilowatt hours or exactly 34,300 British thermal units.

Part I-A. HOUSEHOLD ENERGY EXPENDITURES
(Precise Method)

The most precise method of calculating household energy expenditures is to convert quantities of electricity and fuel used to Energy Units by applying the following conversion factors. If you have not retained bills for the past year, go directly to Part I-B and use the approximate method. If you do use this precise method, omit Part I-B (except for the section on Residential Buildings Materials) and omit the section on Preparing and Preserving in Part III (Foods and Beverages) and the section on Electronic Appliances in Part IV (Leisure Activities).

ELECTRICITY

Multiply total kilowatt hours used in the last 12 months by the conversion factor 0.368. ____

NATURAL GAS

Multiply total cubic feet used in the last 12 months by 0.038. ____

FUEL OIL

Multiply number of gallons used in the last 12 months by 4 5. ____

Divide total energy units by number of users in the household and enter total here and on page 244 of this supplement. ____

Part I-B. HOUSEHOLD ENERGY EXPENDITURES
(Approximate Method)*

HOME APPLIANCES

Values listed in brackets are average Energy Units used per item annually. Multiply by the number of items in the home. Appliances used in preparation and preserving of food will be figured in Part III (Foods and Beverages)

*Note: Use the "approximate method" to verify your utility bills. If your actual bills are much lower than the approximation, be conservative in the rest of this activity. If your bills are higher, compensate raising your estimations for Parts II through VI.

ELECTRIC APPLIANCES

clock	[6]	___
floor polisher	[6]	___
sewing machine	[4]	___
vacuum cleaner	[17]	___
air conditioner	[80]	___
bed coverning	[54]	___
dehumidifier	[128]	___
heating pad	[4]	___
humidifier	[60]	___
germicidal lamp	[52]	___
hair dryer	[5]	___
heat lamp (infrared)	[5]	___
shaver	[0.7]	___
toothbrush	[0.2]	___

vibrator	[0.7]	___
clothes dryer	[365]	___
iron (hand)	[53]	___
washing machine (automatic)	[38]	___
washing machine (nonAutomatic)	[28]	___
water heater (standard)	[1555]	___
water heater (quick recovery)	[1770]	___

GAS APPLIANCES

clothes dryer	[277]	___
water heater	[1170]	___
	Subtotal	_____

HOME LIGHTING

Figures are for average annual use. If your household uses more or less, increase or decrease accordingly.

Electric lighting	[268]	___
Ornamental gas lights	[668]	___
	Subtotal	_____

COOLING AND VENTILATION

CENTRAL AIR CONDITIONING (electric)

New England	[755]	___
Mid-Atlantic	[957]	___
East North Central	[905]	___
West North Central	[905]	___
South Atlantic	[1510]	___
East South Central	[1560]	___
West South Central	[1710]	___
Mountain	[1058]	___
Pacific	[1210]	___

CENTRAL AIR CONDITIONING (gas)	[1046]	___

COOLING AND VENTILATION (noncentral)

fan (attic)	[107]	___
fan (circulating	[16]	___
fan (roll-away)	[51]	___
fan (window)	[58]	___
electric room air conditioner	[316]	___
	Subtotal	_____

SPACE HEATING

ELECTRICITY, NATURAL GAS, OIL, AND SOLAR HEATING

If you have not used the precise method of Part I-A, the following table will provide an estimate of space heating energy expenditure, depending on location and type of heating.

	Electric	Nat. Gas	Oil	Oil/ Solar
Northeast	6480	5360	6380	---
Mid-Alantic	5800	4800	5720	2210
East North Central	6030	4900	5940	2290
West North Central	5350	4440	5280	2040
South Atlantic	4460	3700	4400	1700
East South Central	4040	3330	3960	790
West South Central	2900	2400	2860	570
Mountain	4910	4060	4840	1870
Pacific	3800	3140	3740	1440

COAL

Multiply tons of coal used in the last 12 month by 775. _____

WOOD

Multiply cords used in last 12 months by 620. _____

RESIDENTIAL BUILDING MATERIALS AND GROUNDS

Total home construction energy (including mining, processing, fabrication, transportation, and sales) has been allotted over the average lifetime of the home before major alterations are required. A 25-year span has been chosen for amortization. If your residence was build in the last 25 years, add the following for building materials.

single dwelling [844] ___
2-to-4 unit apartment [642] ___
5-units or more apartment [668] ___
public housing [700] ___

ADDITIONS AND ALTERATIONS
Multiply dollars expended for this purpose during the past year by 1.1
Subtotal _____

LAWN AND GARDEN GASOLINE ENGINES [50]
Subtotal _____

Add all subtotals in Part I-B and divide by number of users in household. Enter total here and on page 244 of this supplement. Total_____

Part II. HOUSEHOLD MATERIALS AND PERSONAL ITEMS

It requires energy to produce all consumer products from house furnishing to cigarettes. Consumer items such as rugs and soap require energy at every step of processing. In calculating Energy Units, it is necessary to include raw materials, processing, freight, and merchandizing. Handcrafting such household materials as drapes does not result in energy savings, since an electric sewing machine probably uses more energy than if mass production methods were used.

HOUSEHOLD MATERIALS
The following Energy Units represent annual expenditures for manufacturing and merchandising household items. Operating energy will be calculated in Part IV for radios, phonographs, and similar items. Energy units are calculated for the individual user. Make allowances if you are a heavy or light user.

furniture [35]
electric appliances [46]
electronic equipment (radio, phonographs, etc.) [17] ___
pottery, earthenware, china [5] ___
other household wares (cutlery, glassware, etc.) [10] ___
rugs and floor coverings [29] ___
other textile furnishings [73] ___
tissues, paper towels, and other household paper products [25] ___
cleaners and soaps [38] ___
Subtotal_____

PERSONAL ITEMS
Adjust, according to whether the individual is a light, normal, or heavy user.

WEARING APPAREL
The large expenditure in the case of women's apparel is due to larger dollar sales and larger energy expenditures of establishments selling such apparel.

men and boys [156] ___
women and girls [204] ___

MISCELLANEOUS
toiletries and beauty aids [23] ___
health and medical supplies [58] ___
tobacco products (1.6 packs per day for average cigarette smokers) [86] ___
shoes, footwear [27] ___
other leather products (luggage, handbags, gloves) [6] ___
photographic supplies [6] ___
jewelry [12] ___
costume jewelry [9] ___
Subtotal_____

Add all subtotals in Part II and enter here and on page 244 of this supplement. Total_____

Part III. FOODS AND BEVERAGES

About 12 percent of America's energy is used to produce, transport, sell, and prepare foods. A large proportion of this is concentrated in meat products. If you do not eat meat, omit the meat category and add extra for vegetables. If you produce your own vegetables by hand and without fertilizer, do not include the 19 Energy Units for vegetables Energy Units are calculated by apportioning food agricultural energy expenditures according to the dollar basis of the food categories in Reference 12 and making adjustments for imports and exports. Average yearly consumption per capita is given in parentheses.

PRODUCTION

meat:		
beef (114.8 lb/yr)		___
veal (2.2 lb/yr)		___
lamb and mutton (3.4 lb/yr)		___
pork (73.0 lb/yr)		___
chicken (42.9 lb/yr		___
turkey (8.9 lb/yr)	[163]	___
dairy products (356.1 lb/yr)	[41]	___
eggs (318 eggs/yr)	[11]	___
vegetables and melons (excluding home gardens; 312 lb/yr)	[20]	___
fruits and nuts (132 lb/yr)	[14]	___
food grain (141 lb/yr)	[7]	___
sugar:		
refined (103 lb/yr)		___
corn syrup (22 lb/yr)	[9]	___
beverages (coffee, tea, cocoa; 18 lb/yr)	[8]	___
edible vegetable oils and animal fats and oils (53 lb/yr)	[17]	___
fish (11 lb/yr)	[11]	___
	Subtotal	_____

TRANSPORTATION OF FOOD TO PROCESSING PLANT AND STORE

Omit if you grow your own produce or buy most of your food at a farm.

	[16]	___
	Subtotal	_____

PROCESSING

meat	[28]	___
dairy products	[24]	___
canned and frozen foods	[28]	___
grain products	[16]	___
bakery products	[13]	___
sugar	[21]	___
confectionery	[4]	___
miscellaneous foods	[32]	___
beverages	[24]	___
	Subtotal	_____

CONTAINERS

The following Energy Units are for one 12-ounce container used per day throughout the year. Adjust accordingly.

BEVERAGE CONTAINERS

refillable glass bottles	[24]	___
one-way glass bottles	[71]	___
bimetallic cans (steel and aluminum)	[57]	___
aluminum cans	[96]	___
distilled beverages or wine	[3]	___
	Subtotal	_____

OTHER FOOD CONTAINERS

paper	[4]	___
steel (cans)	[17]	___
glass	[9]	___
aluminum	[6]	___
plastic	[7]	___
	Subtotal	_____

RETAILING AND WHOLESALING ENERGY EXPENDITURES

Calculated on the basis of grocery sales for various food items.

meat	[46]	___
dairy products	[18]	___

fish	[7]	___
produce	[26]	___
canned and frozen foods	[30]	___
grains and bakery products	[17]	___
sugar and confectionary products	[9]	___
beverages (nonalcoholic)	[13]	___
miscellaneous foods	[18]	___
alcoholic beverages	[31]	___

Subtotal _____

PET FOODS

Multiply the pounds of meat products consumed each week by 50 and the pounds of pet food cereal products by 12 to get the total Energy Units. Then divide this figure by the number of persons in the household who regard the pet as theirs.

Subtotal _____

FOOD PREPARATION AND PRESERVING

If you calculated home fuels by the precise method in Part I-A, or if all your meals are eaten out, this section should be skipped.

ELECTRIC APPLIANCES

blender	[6]	___
broiler	[37]	___
carving knife	[3]	___
coffeemaker	[39]	___
deep fryer	[30]	___
dishwasher	[133]	___
egg cooker	[5]	___
freezer (15 cubic ft)	[440]	___
freezer (frostless, 15 cubic ft)	[648]	___
frying pan	[68]	___
hot plate	[33]	___
mixer	[4]	___
oven (microwave only)	[70]	___
range (self-cleaning)	[443]	___
range (regular)	[432]	___
refrigerator (12 cu. ft)	[268]	___
refrigerator (frostless, 12 cu. ft.)	[448]	___
refrig-frzr, 14 cu. ft.	[418]	___
refrigerator-freezer, (frostless, 14 cu. ft.)	[673]	___
roaster	[75]	___
sandwich grill	[12]	___
toaster	[14]	___
trash compactor	[18]	___
waffle iron	[8]	___
waste disposer	[11]	___

GAS APPLIANCES

outdoor gas grill	[100]	___
range (apartment)	[350]	___
range (single unit)	[389]	___
refrigerator	[509]	___

Add Energy Units for electric and gas appliances and divide by number of users in household to get subtotal

Subtotal _____

Add all subtotals in Part III and enter total here and on page 244 of this supplement. Total _____

Part IV. LEISURE ACTIVITIES

Estimates for leisure activities outside the home vary considerably with distance traveled, means of transportation, equipment used, and frequency of use.

ELECTRONIC APPLIANCES

Omit if you estimated electricity used by the precise method in Part I-A. Energy expenditures for materials have already been calculated under Household Materials in Part III Figures are for operation only, computed on the basis of average electric use per item per year (4 hours daily for television, 6 hours weekly for stereo). Adjust accordingly.

radio	[31]	___
radio/record player	[40]	___
stereo	[14]	___
television		
black & white (tube)	[129]	___
Black & wh. (solid state)	[44]	___

color (tube) [243] ___
color (solid state) [162] ___
Subtotal _____

CULTURAL AND LITERARY RECREATION

LITERARY ACTIVITIES
newspapers [95] ___
books [36] ___
periodicals [15] ___
use of typewriter (materials and operation) [1] ___
Subtotal _____

CRAFTS

Activities such as designing, floral arranging, knitting, and sewing require less than 1 Energy Unit and have been omitted. For other activities, add Energy Units according to the following scales, adjusting figures for more intensive, normal, and less intensive use.

[1 to 10 Energy Units]
Painting, drawing, leatherwork, woodcarving, sculpturing, stamp collecting, coin collecting, collecting articles such as bottles.

_____

[10 to 100 Energy Units]
Woodworking (with electric lathe), pottery work (with kiln), metalworking (with forge or oven), recording

_____

MISCELLANEOUS ACTIVITIES
visits to amusement parks [20] ___
motion pictures (8-9 movies per year) [9] ___
toys [14] ___
musical instruments [8] ___
Subtotal _____

SPORTS

Outdoor spectator sports require very small amounts of energy (except for night baseball games and the like) and may be omitted. Some participative sports (jogging, hiking, and most field events) require only human energy. Others, such as baseball football, other ball games, swimming (in unheated pools), surfing, canoeing, skating (on natural ice), fishing (without a motor boat), **biking**, sledding, and indoor gymnastics (yoga, karate, judo, acrobatics) require less than 1 Energy Unit and may also be omitted. For other participative sports, add Energy Units according to the following scales, adjusting figures for more intensive and less intensive use. Let your conscience be your guide.

[1 to 10 Energy Units]
Indoor basketball, volleyball, wrestling, boxing, squash, handball, outdoor tennis, go-carting, camping, small-boat sailing.

_____

[10 to 100 Energy Units]
Tennis (on clay court), skiing, horseback riding, mountain climbing, caving, scuba diving.

_____

[More than 100 Energy Units]
Bowling with automatic pins, indoor swimming (private), motor boating, water skiing, snowmobiling, fox hunting, field polo, deep-sea fishing, yachting, airplane flying, dune buggy riding Subtotal _____

Add all subtotals in Part IV and enter total here and on page 244 of this supplement. Total _____

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Part V. TRANSPORTATION

All forms of transportation considered below include a factor for associated costs (fuel refining and retailing, vehicle manufacture and maintenance. insurance, etc.) except for highway construction, which is included in Part VI under Public Services. Energy consumed in freighting is included in the consumer product or service and is thus not counted separately here.

NONBUSINESS TRAVEL

PRIVATE CAR

This is a major part of your lifestyle energy use and should be calculated as closely as possible. First, determine the number of non business miles traveled each year by subtracting miles of business travel from annual car mileage. Divide by the average number of passengers. Then multiply this figure by the following number, depending on your car's miles per gallon (mpg).

8 mpg.	Multiply by	0.50
14 mpg.	" "	0.29
20 mpg.	" "	0.20
25 mpg.	" "	0.16 _____

MOTORCYCLE

Divide number of nonbusiness miles each year by average number of riders (if any) and multiply by the following number, depending on miles per gallon.

50 mpg.	Multiply by	0.08
100 mpg.	Multiply by	0.04
160 mpg.	Multiply by	0.025 _____

GAS, OIL, TIRES, MAINTENANCE, INSURANCE, PARKING

For private car or motorcycle, multiply Energy Units calculated directly above by 0.395. _____

VEHICLE CONSTRUCTION AND RETAILING

This assumes the life of your vehicle is average (about 8 years). Divide the weight of the vehicle by the number of users and multiply this figure by 0.154. _____

OTHER NONBUSINESS TRANSPORTATION

Multiply the number of miles traveled per year by the figures indicated.

train	0.094	_____
highway bus	0.042	_____
urban mass transit	0.14	_____
commercial aircraft	0.30	_____
modern cruise liner	0.48	_____
yacht	1.4	_____
bicycle	0.016	_____
	Subtotal	_____

RIDING TO WORK

The multiplying factors here are larger than in the preceding section because they include associated costs, such as vehicle maintenance and construction.

PRIVATE CAR

First determine annual mileage by multiplying round trip in miles by workdays per year. Divide by the number of passengers and then multiply this figure by the following number, depending on the car s miles per gallon (mpg).

7 mpg.	Multiply by	0.80
10 mpg.	" "	0.56
14 mpg.	" "	0.40
21 mpg.	" "	0.27
28 mpg.	" "	0.20 _____

MOTORCYCLE

Divide miles per year by average number of riders (if any) and multiply by the following number, depending on miles per gallon.

50 mpg.	Multiply by	0.11
100 mpg.	" "	0.056
160 mpg.	" "	0.036 _____

BICYCLE
Multiply miles per year by 0.016 _____

PUBLIC TRANSPORTATION
Multiply miles traveled per year by the following number.

urban mass transit	0.14	_____
intercity train	0.094	_____
highway bus	0.042	_____
	Subtotal	_____

Add all subtotals in Part V and enter here and on page 244 of this supplement. Total _____

Part VI. SOCIAL AND COLLECTIVE SERVICES

PRIVATE SERVICES
In addition to the personal uses of energy considered so far, certain social and collective uses must be charged to the ultimate consumer on a per capita basis. We may not attend schools or use hospitals ourselves, but it is necessary to expend energy to keep them available. If you are sure that certain services do not apply to you (for instance, beauty parlors), they may be omitted. Multiply by 2 for heavy use; divide by 2 for light use.

LEGAL	[43]	____
NONPROFIT (INCLUDING RELIGIOUS)	[56]	____
PERSONAL		
laundries	[18]	____
beauty parlors	[8]	____
barber shops	[3]	____
photographic services	[2]	____
shoe repair	[1]	____
funeral services	[5]	____
REPAIRS (NONAUTO)	[13]	____
MOTELS AND LODGINGS	[26]	____

BUSINESS SERVICES

advertising, sign painting	[32]	____
services to buildings	[5]	____
business and consulting	[12]	____
credit	[3]	____
duplicating, mailing, steno	[3]	____
commercial research and testing	[5]	____
detective services	[2]	____
equipment rental	[5]	____
trading stamps	[3]	____
	Subtotal	_____

PUBLIC SERVICES
All citizens have access to the following services and facilities. If all of them apply, your subtotal should be 631. The Energy Units listed apply to both construction and operation.

hospitals (public and private)	[211]	____
education (public and private)	[80]	____
telephone service (3 calls per day)	[21]	____
other public utilities	[46]	____
highway construction and maintenance	[186]	____
conservation and development of resources	[11]	____
sewer systems	[17]	____
water systems	[47]	____
trash collection	[12]	____
	Subtotal	_____

GOVERNMENT SERVICES
Government services are major users of energy. Since all are benefited (or harmed) by these services, the total energy expended must be divided among all citizens. Reliable statistics are available for federal energy expenditures. That is not the case for state and local government services. They are

estimated here to be equivalent to the federal government's non-military energy expenditures in comparable areas.

FEDERAL GOVERNMENT

The major user of energy in the federal government is the military, with 603 Energy Units per capita annually. Total federal expenditure, printed as your subtotal, is 709 Energy Units.

Subtotal 709

STATE AND LOCAL GOVERNMENTS

Construction not previously included amounts to 27 Energy Units. Maintenance of fire and police departments, etc., accounts for another 100.

Subtotal 127

POSTAL SERVICES

Per capita energy expenditure for the average person (824 pieces sent or received each year--or about 16 per week) is 31 Energy Units. Adjust accordingly.

Subtotal ____

Add all subtotals in Part VI and enter total here and in the space below.

Total _____

Enter below the Energy Unit totals for each of the six parts of the Lifestyle Index as each is completed. Then find your grand total.

Part		Energy Units
I.	Household Energy Expenditures (A. Precise Method; B. Approximate Method)	
II.	Household Materials and Personal Items	
III.	Foods and Beverages	
IV.	Leisure Activities	
V.	Transportation	
VI.	Social and Collective Services	
	GRAND TOTAL	

You should now compare your total annual expenditure of energy with that of the average U.S. citizen (10,000 Energy Units) and with those of citizens of other countries given below:

ANNUAL ENERGY UNITS PER CAPITA IN SELECTED COUNTRIES

Afghanistan	23	Brazil	435	Congo	212
Albania	524	Burma	57	Costa Rica	378
Angola	130	Burundi	9	Cuba	949
Argentina	1490	Cameroon	82	Czechoslovakia	5590
Australia	4600	Canada	7870	Dahomey	30
Austria	2890	Chad	23	Denmark	4495
Bahamas	4285	Chile	1255	Ecuador	263
Barbados	975	China	473	Egypt	241
Bolivia	175	Colombia	559	El Salvador	171

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Ethiopia	34	Kenya	145	Puerto Rico	3230
Finland	3655	Khmer Republic	20	Saudi Arabia	813
France	3314	Kuwait	8610	Singapore	1320
Gabon	874	Laos	71	Spain	1406
Germany	4412	Lebanon	709	Sweden	5140
Ghana	157	Liberia	313	Switzerland	3015
Greece	1240	Malagasy Republic	62	Tanzania	59
Greenland	3750	Mali	21	Turkey	436
Guatemala	196	Mexico	1072	Uganda	61
Guinea	85	Mozambique	148	U.S.S.R.	3825
Haiti	24	Morocco	171	United Kingdom	4650
Honduras	183	Nepal	8	United States	9500*
Hong Kong	862	Netherlands	4325	Uruguay	775
Iceland	3640	Nicaragua	324	Venezuela	2107
India	157	Niger	21	Yemen	11
Indonesia	106	Nigeria	50	Yugoslavia	1360
Iran	865	Norway	4400		
Ireland	2830	Pakistan	68		
Israel	2245	Panama	662		
Italy	2245	Paraguay	119		
Ivory Coast	238	Peru	519		
Jamaica	1068	Philippines	246		
Japan	2755	Poland	3690		
Jordan	260	Portugal	685		

WORLD AVERAGES

With United States 1630
Without United States 1167

*This represents the per capita U.S. energy expenditure for 1971. The figure for 1972 (latest year on which computations could be based) is 10,000 Energy Units.
Source: *World Energy Supplies*, Statistical Papers. Series J. No. 16, United Nations, New York, 1973 (converted into Energy Unit values by the author).

Source: (Adapted from)
Lifestyle Index
Contrasumers by Alfred J. Fritsch

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DEFINITIONS OF CONSERVATION AND CURTAILMENT[26]

Both conservation and curtailment are activities which lead to reduced energy demand. *Conservation* is defined as the wise use of energy which results from a rational response to price changes or a shift from less to more available fuel resources. Conservation does not connote a denial of the "American dream," though many people believe that this is so. Rather, conservation attempts to change citizens from being high energy users to low energy users by reinforcing "saver" values in pragmatic, money-saving terms.

Curtailment, on the other hand, is a short-run strategy that is used to cope with acute energy shortages; for example, an oil embargo would induce curtailment or cutting-back of petroleum consumption among those affected by the embargo. Curtailment requires denial. If we conserve our energy resources now, we can avoid possible curtailment of these resources in the future.

Conservation is a long-term necessity that should be implemented for five basic reasons:

1. Conservation saves money; lower cost material resources can often be used to achieve the same ends as high cost energy resources.
2. Conservation can expand our range of energy choices because it permits us to select those energy supply technologies that are most acceptable (for example, solar energy) and reject those that are relatively objectionable (for example, coal energy).
3. Scarce energy resources can be freed for use in developing countries by conservation. The value of an incremental supply of energy in a developing country may be much greater than in a developed country.
4. The U.S. dependence on unreliable and costly supplies of foreign oil can be reduced by conservation measures.
5. Conservation measures will help provide energy resources for future generations; they will help to prevent future generations from having reduced standards of living. [adapted from Moss, pp. 1-26]

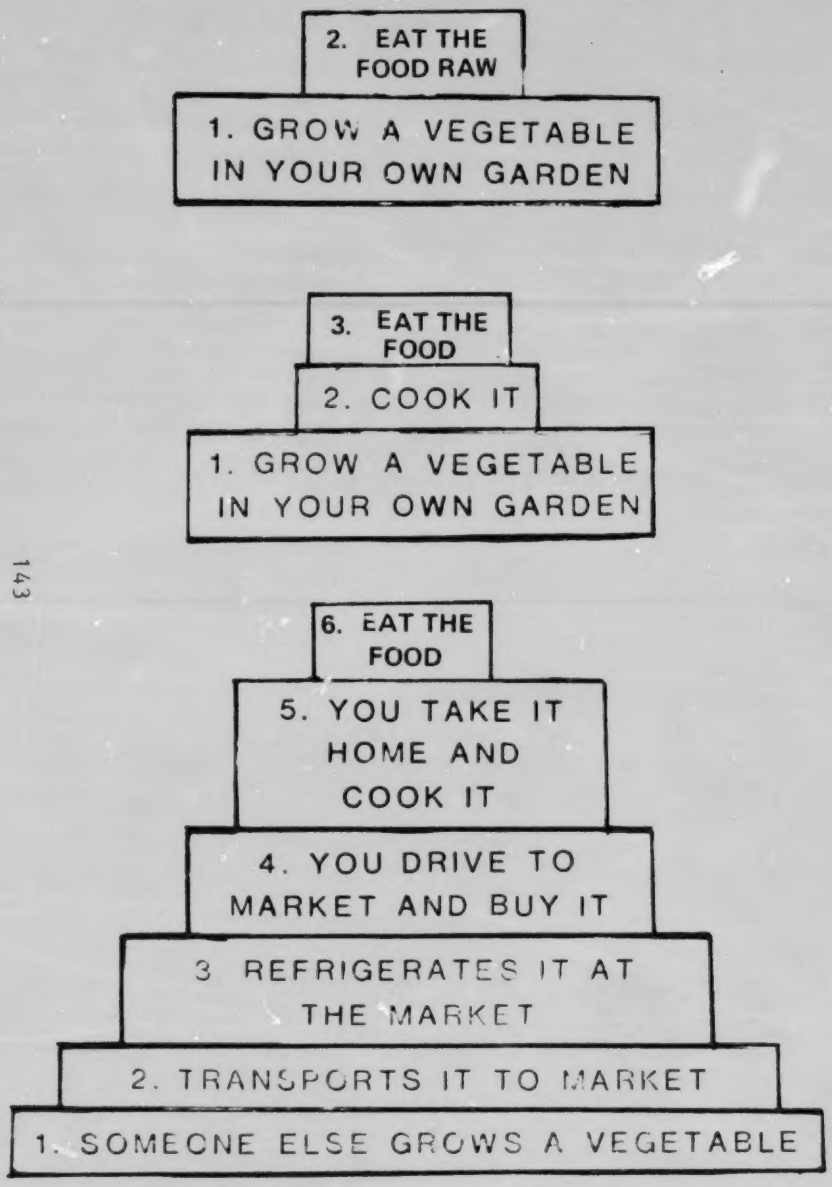
Conservation is not an end in itself. A 1976 FEA conservation paper entitled "Group Discussions Regarding Consumer Energy Conservation" found that energy conservation is generally viewed as a "time-buying" strategy that will be implemented only until some new, infinite, inexpensive source of energy is found. The American society can then continue to be spoiled, self-indulgent, and extravagant. Many pre-teenagers

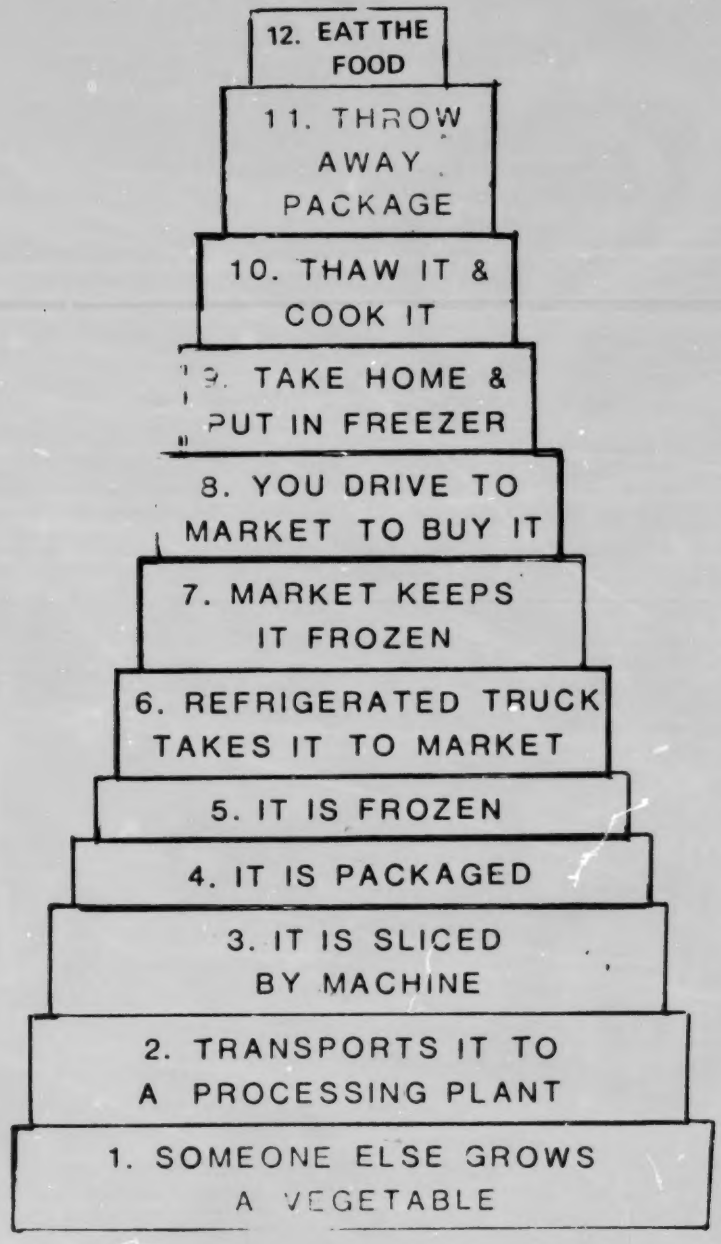
romantically believe that a "Star Trek" world, with its "new" energy resources, will be theirs or at least their children's. But the "new" energy resources (fusion, for example) may not be implemented for quite a long time and, when they are, will probably be more expensive than we think. Until such resources are developed, we must act with the belief that "new" resources may never be available.

Citizens must become aware of the need for and economic rationality of energy conservation. *It's simply a strategy for getting the most for our money.* Home economics teachers especially are in a position to promote this understanding, but they should take note of the following warning in the *Citizen Action Guide to Energy Conservation:*

> *It should go without saying that if you are not practicing energy conservation, you can't very well ask others to do so--your enthusiasm and success will be the best reason that others will want to join you.* [p. 55]

After home economics teachers have put into practice their conscious decisions to practice good conservation before they urge conservation measures on their students, they must carefully formulate for class presentation a whole range of reasons to justify their support of energy conservation. Their support of conservation measures should be based not only on national, social, political, and economic reasons, but also on a moral sense of waste and the need for stewardship--*an energy conservation ethic.*


2. EAT THE FOOD RAW
1. GROW A VEGETABLE IN YOUR OWN GARDEN
3. EAT THE FOOD
2. COOK IT
1. GROW A VEGETABLE IN YOUR OWN GARDEN
6. EAT THE FOOD
5. YOU TAKE IT HOME AND COOK IT
4. YOU DRIVE TO MARKET AND BUY IT
3 REFRIGERATES IT AT THE MARKET
2. TRANSPORTS IT TO MARKET
1. SOMEONE ELSE GROWS A VEGETABLE


12. EAT THE FOOD
11. THROW AWAY PACKAGE
10. THAW IT & COOK IT
9. TAKE HOME & PUT IN FREEZER
8. YOU DRIVE TO MARKET TO BUY IT
7. MARKET KEEPS IT FROZEN
6. REFRIGERATED TRUCK TAKES IT TO MARKET
5. IT IS FROZEN
4. IT IS PACKAGED
3. IT IS SLICED BY MACHINE
2. TRANSPORTS IT TO A PROCESSING PLANT
1. SOMEONE ELSE GROWS A VEGETABLE

Discover Your Energy Identity

AN ENERGY CONSERVATION ETHIC [26]

One hundred years ago, the Industrial Age swooped down upon us without warning. It tantalized with promises and visions of prosperity forever in a nation overabundant with natural resources. The Protestant Work Ethic that had established this country gave way under pressure to the demands of a "Consumer Society." Concern with production rates became paramount; concern with use of energy and natural resources was ignored. "Real" costs of manufacturing were misleading in a time when energy costs were artificially low and/or government subsidized. Products were *designed* to be tossed out after one use or *replaced* by newer models each year (planned obsolescence). New technologies were instituted in our factories, homes, and offices without regard to energy use or efficiency. Such attitudes and practices quickly led to complacency and false security in our highly energy-intensive society.

A growing number of Americans are beginning to realize the value and necessity of a revised lifestyle which includes both "Voluntary Simplicity" and an "Energy Conservation Ethic." Such changes in attitude and thought can carry us beyond cost-saving responses. This new ethic is based on a realistic comprehension that many of the raw materials on which current living standards rely will be expended in the foreseeable future. If but for the sake of future generations, we must awaken in ourselves "a moral sense of waste and greed" that will lead to the acceptance of an Energy Conservation Ethic.

Conservation is a rational act to achieve and maintain an amenable lifestyle at minimum price. Such an achievement cuts waste. For example, wasteful use of heating oil can be decreased by adding more insulation to a home. In the long run, money will be saved. Also, conservation measures increase efficiency. For example, you can buy an air conditioner that is more energy efficient than another air conditioner of comparable size and quality. The air conditioner may be more expensive to buy than the less efficient model, but in the long run more dollars will be saved in operating the more efficient model than the difference in cost between the two models.

It is true that conservation can affect employment, but it is not necessarily true that conservation *cuts* employment. For example, decreasing the production of disposable bottles leads to a decrease in the number of people required to produce the disposable bottles, a decrease in the number of people needed to pick them up, and a decrease in the number of people needed for hand-filling the bottles. But on the other hand, returnable bottles must be transported to the factory and washed. Actually, returnable bottles require more net jobs than disposable "one-way" bottles. Another example: jobs lost in the oil or electrical industry due to a lower consumption of heating oil or electricity are more than off-set by jobs installing insulation.

Because an Energy Conservation Ethic may be a difficult concept to grasp, we must make a major effort to understand our energy situation and foster in ourselves an awareness of the difference between essential needs and nonessential desires. The individual who possesses an Energy Conservation Ethic gives great though to the following questions before buying any product, whether it be an air conditioner, can opener, or synthetic fabric:

1. *Do I really need it to be happy?*
2. *What could be used as a substitute or alternative?*
3. *Will buying it promote a more materialistic lifestyle?*
4. *Is it inexpensive, yet efficient, in terms of total cost?*
5. *How long will it last?*
6. *Can it be recycled?*
7. *What resources are in it?*
8. *Are the energy resources scarce or nonrenewable?*
9. *From what countries do the resources come?*
10. *Are there other resources which could be used to make it?*
11. *Did its production result in significant environmental/ ecological damage?*
12. *Will its use result in significant environmental/ ecological damage?*

An "Energy Conservation Ethic" is a conscious effort on the part of the individual to think in terms of wise and efficient use of resources when developing, buying, or consuming them. It reminds one of the "stewardship" responsibility to maintain an ecological balance for survival, that the natural environment is not limitless in its capacity to assimilate waste and abuses.

Several types of energy conservation activities are implied by an Energy Conservation Ethic:

1. Activities that can save energy as well as money.

2. Activities that save energy and have no apparent disadvantages.

3. Activities that save energy but have some minor associated disadvantages.

Keeping thermostats set in the winter at 65 degrees and in the summer at 78 degrees falls in the first category; not only does this action save money, but it can improve one's health. Installing storm windows and doors is also in this category; these items can quickly pay back their initial costs through lower utility bills. The same is true in the case of additional insulation, especially in older homes; the cost of insulation is normally less than the amount of money the resident will save over time on energy bills. Carpooling is another way to save both money and energy. Buying fresh produce rather than canned, frozen, or dehydrated produce is

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yet another way; for example, the production of one pound of white potatoes (excluding packaging) requires:

6,250 Btu's - fresh
9,000 Btu's - canned
14,950 Btu's - frozen
26,700 Btu's - dehydrated
[Energy and Food, p. 1]

Besides, fresh potatoes cost less at the store.

Appliances that save energy because they are more efficient than comparable products have no apparent disadvantages for the homeowner; therefore, these products fall in the second category. For example, the possible additional price of a more energy efficient air conditioner may be offset by lower energy bills. Furthermore, there is no apparent disadvantage to avoiding products with excessive packaging. Every supermarket plastic bag adds approximately 170 Btu's to the product's total energy expenditure.

Using returnable beverage containers saves energy and creates only minor disadvantages for the homemaker. A 16-ounce RC Cola returnable bottle requires 7,836 Btu's to produce and can be reused 10 to 15 times. On the other hand, a 16-ounce, non-returnable RC Cola bottle requires 6,002 Btu's to produce and can be used just once.

The following "Energy Conservation Creed" is a possible expression of the energy conservation ethic:

I pledge that I will learn to participate automatically in all those conservation activities which have no apparent disadvantages to myself and which require minimal energy on my part.

I further pledge that although certain conservation activities may have minor personal disadvantages, I will volunteer to participate in them.

And in the event that these activities are not sufficient, I will tolerate those activities which may produce serious disruptions in my lifestyle.

I pledge all this in the interest of future generations.

It is hoped that this or a similar creed will be instilled in teachers and in their students and that students will urge their parents to participate in conservation activities. Educators can help the Energy Conservation Ethic become a way of life; educators can help create a more efficient, durable society that cares about the energy inheritance it will bequeath to future generations.

SOURCES

Wilson Clark. "It Takes Energy to Get Energy: The Law of Diminishing Returns Is in Effect," *Smithsonian*, December, 1974, pp. 86-87.

John H. Gibbons and Roger H. Sant. "The Role of Conservation in the Changing Economics of Energy." *The Changing Economics of World Energy*, edited by Bernhard J. Abrahamsson. Boulder, Colorado: Westview Press, 1975.

Laurence I. Moss. "Energy Conservation in the U.S.: Why? How Much? By What Means?" *Energy Conservation Training Institute*. Washington, D.C.: The Conservation Foundation, 1976.

Citizen's Advisory Committee on Environmental Quality. *Citizen Action Guide to Energy Conservation*. Washington, D.C.: Government Printing Office, 1973.

"Energy and Food Wrapped Together," *Center for Science in the Public Interest Newsletter*, Vol. 5, No. 2 (Summer, 1975).

ACTIVITY W AN ENERGY ETHIC [26]

OBJECTIVE: TO ENCOURAGE AN ENERGY CONSERVING ETHIC FOR STUDENTS

Below you will see a list of items and activities which require energy for their manufacture, use, and disposal. Number (rank) these items in order of importance and necessity to you. Mark your responses in column A--number 1 being most important on down to number 20 for least important.

A	B	C
___ watching television	___	___
___ hot water for bathing	___	___
___ electric toothbrush	___	___
___ waffle iron	___	___
___ synthetic clothing	___	___
___ reading a book	___	___
___ eating a raw apple	___	___
___ TV dinners	___	___
___ car ride to the store	___	___
___ drive-in movie	___	___
___ making homemade ice cream	___	___
___ lipstick or cologne	___	___
___ aerosol deodorant	___	___
___ electric hairdryer	___	___
___ bike riding	___	___
___ a walk in the sun	___	___
___ candy	___	___
___ nighttime football games	___	___
___ hot lunches	___	___
___ school buses	___	___

Now that you have ranked these items according to their importance to you, go back and rank the ones you feel are *most energy intensive* in Column B (from "1 to "10".) Discuss your answers in class.

Now mark in Column C the items you could do without which would help you and our nation conserve energy. Discuss your answers in class.

Suggestions:

1. Develop an Energy Alternatives bulletin board for the school.

TEXAS TECH

TIPS and TOPICS IN HOME ECONOMICS

ENERGY EDUCATION

Vol XXI, No 4, Summer 1981

Voluntary Simplicity of Lifestyle: Shaping the Future

Leo Christie and Ruth Pestle

The growing awareness that humankind is rapidly using up the finite supplies of non-renewable natural resources is of increasing concern in today's world. In a recent energy message, the president of the United States indicated that without decisive steps toward energy conservation, the country would see radical changes in the American lifestyle within the next 20 years.[10] Like Americans, many other people of the world have taken for granted the expectation that they will be able to continue living in climate-controlled dwellings filled with electrical conveniences and ride in private vehicles to climate-controlled workplaces, also filled with electrical conveniences. The problem is that Mother Nature is about to pull the plug on this electrical-powered modern dream.

Harbingers of this imminent worldwide power failure have been evident for some years, in the skyrocketing price of gasoline, empty fuel-oil tanks in the dead of winter, and electrical blackouts on hot August nights. According to various United States Government reports, the world may have only a few decades of petroleum and natural gas left and possibly a few hundred years of coal supplies.[10]

Two other natural resources upon which the delicate balance of human existence is dependent—pure air and water—are threatened by pollutants produced by the dumping of various industrial and home wastes and the burning of fossil fuels. Although the causes of water and air pollution may be centered in industrialized nations, the problem is a global one, given the natural interchange of the world's water system and the world-wide flow of high-altitude air currents.

A final global issue to be noted here is that of the inequitable distribution of food supplies throughout the world—specifically, the shortage of protein sources in many parts of the world. There appear to be at least half a billion people in the world today who are malnourished, over half of them children under five years of age.[1] This situation is particularly shameful in light of the fact that other peoples of the world are over-nourished and wasteful of food resources. In line with the co-existence of feast and famine in today's world is the fact that the world is closer to global famine now than it has been for decades, despite remarkable advances in food production over the last 25 years.[7] The situation is likely to become worse before it becomes better, in view of the projected increase in world population from four to seven billion by the year 2000.[8]

A final and most important point to be made is the interrelatedness of (1) global, national, local, and personal concerns, and (2) the present and the future. National concerns may be characterized by the threat to national security posed by the fact that Americans, comprising 5.4 percent of the world's population, consume 30 percent of the world's resources.[2] Local concerns are those such as depersonalized lifestyles in modern communities, and personal concerns are the lack of personal fulfillment and sense of being cut off, as described by Alvin Toffler in *Future Shock*.[9] Global concerns and global solutions cannot possibly be seen as separate from national, local, and personal concerns and solutions. Nor can the future be seen as separate from the present. What individuals do to solve or create current problems affects how the world deals with current and future problems. From this we may draw two conclusions. First, the ways that individuals choose to live their lives shape the way the world is. Second, the way that we live in the present will shape the future.

One Solution: Voluntary Simplicity

While it would be naive to suppose that any one solution could effectively solve all the problems listed above, Voluntary Simplicity has a certain amount of appeal in that it does address all of the problems listed and in that it begins at the level of individual motivation. In undertaking to explain what Voluntary Simplicity is, perhaps it is useful to begin by stating what it is *not*. One thing Voluntary Simplicity is *not* is a *new* idea. People living today who experienced World War I or II and the Depression learned to live simply due to necessity, and many of those people still hold the same values and choose to utilize resources conservatively. Also, as early as 1936, the term "voluntary simplicity" was being used[6] with essentially the same concepts and values that it carries today. One other thing Voluntary Simplicity is *not* is a "back to nature" movement, as characterized by living in poverty or as a fad confined to our country.[3]

What Voluntary Simplicity *is* is a lifestyle. It is living in a way that is outwardly simple and inwardly rich and embraces "frugality of consumption, a strong sense of environmental urgency, a desire to return to living and working environments which are of a more human scale, and an intention to realize our human potential—both psychological and spiritual—in community with others."[5] Emphasis is on material simplicity, recycling of used goods, use of renewable resources, sharing of goods and services with other people, and cooperation in discovering creative solutions to common problems.

Some examples of carrying out all the ideals just listed might be the following: using only those resources like water and food one needs, neither more nor less; re-using materials like glass, paper, and textiles wherever possible; using renewable resources like solar energy rather than nonrenewable ones like petroleum; and sharing the use of appliances like clothes dryers and lawn mowers with other families, rather than each family having its own complete set of appliances. In short, Voluntary Simplicity is the opposite of a consumeristic society in which many disposable items are produced for the sake of convenience.

Voluntary Simplicity

An important point to be made is that Voluntary Simplicity is *not* limited to a single lifestyle, but may embody many different styles of living, applicable to people of different income levels. For example, several families may choose to live together, sharing living space and appliances and exchanging goods and services. But communal living is only one example of living Voluntary Simplicity. Another family may choose to live in a home which takes maximum advantage of solar energy. Still another may lead a traditional lifestyle but give special attention to conserving all resources and re-using materials wherever possible. All of these lifestyles are examples of practicing Voluntary Simplicity.

How Can Voluntary Simplicity be Implemented?

One way that the concepts and values of Voluntary Simplicity can be disseminated is by teaching them in the schools. In Florida, the Division of Vocational Education of the Florida Department of Education has recognized the severity of the global problems noted above and has funded a research project to integrate Voluntary Simplicity into home economics curricula. In Phase I of the project, an attitude survey was developed, the goal being to produce a valid and reliable instrument for measuring people's lifestyle-related attitudes. Phase II involves actually integrating Voluntary Simplicity into existing high school home economics curriculum. The attitude survey and the curriculum are currently being field tested in high schools throughout Florida.

The new curriculum is intended to accomplish the actual nuts and bolts of incorporating Voluntary Simplicity concepts into the Family Relations, Occupations, Food and Nutrition, Clothing and Textiles, and Housing areas of the Florida home economics curriculum. Some of the teaching strategies incorporated into the curriculum are team teaching, use of resource persons, field trips, debates, role playing, and taking home Voluntary Simplicity concepts for family discussions.

In view of the urgent nature of the global problems outlined above, it is gratifying that some creative solutions are being proposed. Voluntary Simplicity is a solution with a great amount of appeal because it addresses itself to all the problems and because it is something which individuals themselves can do *now*, without waiting for government action. There are two considerations which make this enhancement of traditional home economics curriculum a new emphasis. First, while home economics has always stressed conservation, current and future concerns reach beyond family economizing, far into the realm of urgent global necessity. Second, today's high school students face more critical survival choices and have more powerful technology available to them than any foregoing generation.[9] If Voluntary Simplicity can be taught to young people who are the shapers of the future, then that future can be whatever we want it to be. The point is that the time for shaping the future is *now*, the present, and Voluntary Simplicity is a way to shape a brighter future that is in harmony with the natural limitations of the planet on which we live.

For more information on the Voluntary Simplicity curriculum, write Dr. Ruth Pestle, College of Home Economics, Department of Home Economics Education, Florida State University, Tallahassee, Florida, 32306.

1. Barnet, R.J. "A Reporter at Large: The World's Resources, Part II." *The New Yorker*, March 31, 1980, 40.
2. Center for Science in the Public Interest. *99 Ways to a Simple Lifestyle*. Garden City, New York: Anchor Books, 1977, xi.
3. Cornille, T.A., Oransky, K.S., and Pestle, R. "Changing Family Lifestyles: Adapting to the Energy Crisis." *Journal of Home Economics*, Winter, 1979, 36-37.
4. Cornish, E. "An Agenda for the 1980's." *The Futurist*, 1980, *14* (1), 5-13.
5. Elgin, D.S. and Mitchell, A. "Voluntary Simplicity." *The Co-Evolution Quarterly*, Summer, 1977, 4-19.
6. Gregg, R.B. "Voluntary Simplicity." *The Visva-Bharati Quarterly*, August, 1936.
7. Groth, E. "Increasing the Harvest." In Burch, W.R. (Ed.) *Readings in Ecology, Energy, and Human Society: Contemporary Perspectives*. New York: Harper & Row, 1977.
8. Simple Living Collective, American Friends Service Committee. *Taking Charge: Achieving Personal and Political Change through Simple Living*. New York: Bantam Books, 1977, 269.
9. Toffler, A. *Future Shock*. New York: Random House, 1970.
10. U.S. Department of Energy. *Tips for Energy Savers*. Washington, U.S. Government Printing Office, 1978.

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ACTIVITY S RESIDENTIAL ENERGY CHECKLIST[26]

OBJECTIVE: TO PROVIDE AN EASY AND QUICK SCAN OF THE HOME TO REVEAL POSSIBLE SOURCES OF ENERGY WASTE AND POTENTIALS FOR ENERGY CONSERVATION.

Individuals and families are managers of resources. Management of energy could be improved with knowledge of how to conserve resources.

The following energy checklist can be used by you (the student), your parents, and relatives as a handy guide to systematically search for residential energy waste and potentials for conservation. The checklist does not attempt to quantify the energy loss, nor estimate the cost to aleviate the problems. In some cases, it might not be practical to try to elimate the waste, but rather to reduce it or its impact. Refer to additional sources of information; for example, if you find several problems under home construction, or food preparation, or any other general area.

RESIDENTIAL ENERGY CHECKLIST

House: The Shell	yes	no
1. Are plants properly located around the house to provide a break against wind and shade against unwanted sun?		
2. Are drapes and furniture located so they do not obstruct heating, air-conditioning or ventilation?		
3. Are draperies insulated?		
4. Do draperies fit snugly around the window?		
5. Are exterior house doors closed quickly after use?		
6. Are lights and appliances turned off after use?		
7. Do you have storm windows and doors?		
8. Are all doors and windows properly caulked and weatherstripped?		
9. Are draperies and shades closed at night and on cloudy, windy days during the heating season?		
10. Are draperies opened to admit sunlight on sunny days in the heating season?		
11. Are draperies and shades closed on sunny days during the cooling season?		
12. Is the attic ventilated?		
13. Is the attic insulated to 6-8"?		
14. Are the walls insulated?		
15. Do floors exposed to unheated or cooled air have from 2-3½" of insulation?		
16. Is the fireplace damper closed when not in use?		
17. Is the den, gameroom or family room oriented to the south?		
18. Is the house shaded from the western sun?		

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	yes	no
19. Does your home have window area equivalent to 10% or less of its square footage?		
20. Is your home sealed from drafts? Is it free from cracks and holes?		
21. Does your home have fluorescent lighting where appropriate?		
22. Does your home have wall-to-wall carpeting?		
23. Do all windows have drapery, shades, blinds, shutters or other covering?		
Environmental Control		
24. Are ducts, radiators or air-conditioners closed off in unused rooms or closets?		
25. Are hot water pipes insulated in unheated and uncooled spaces?		
26. Are air ducts insulated in unheated and uncooled spaces?		
27. Is the thermostat set at 65°F or below during the heating season?		
28. Is the thermostat set at 78°F or above during the cooling season?		
29. Are heating and cooling filters clean?		
30. Is the thermostat turned back at night?		
31. Are windows and doors tightly closed while mechanically heating or cooling?		
32. Is an attic fan used in the summer?		
33. Do thermostats indicate correct temperature settings?		
34. Is an outside air-conditioning unit located on the shady (north) side of the house?		
35. Is the water heater insulated?		
36. Is the water heater temperature setting at 140°F or less?		

	yes	no
37. Is the air-conditioning unit properly sized for your needs?		
38. Do you have a heat pump?		
39. Do you use natural ventilation as much as possible?		
40. Are radiators and other heating or cooling equipment clean and dust free?		
41. Is the water heater located in a heated space?		
Housing Selection		
42. If you live in an apartment, is it an "inside" apartment?		
43. If you live in a mobile home, does it have a "skirt"?		
44. If you live in an older home, have its plumbing, wiring, insulation and chimneys been checked by "experts"?		
Food		
45. Is the frost on the refrigerator and freezer less than ¼ inch thick?		
46. Is the refrigerator set at 40°F?		
47. Is the freezer set a 0°F?		
48. Are gaskets around refrigerators and freezers tight?		
49. Is the oven used to bake more than one food at a time?		
50. Is the gasket around ovens tight?		
51. Are frozen foods thawed completely before cooking?		
52. Is the cooking range turned off immediately after use?		

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	yes	no
53. Are dishes washed only when there is a full load?		
54. Are dishes allowed to air dry?		
55. Are appliances clean and dust free (particularly cooling coils)?		
56. Is the oven never used as a dryer or heater?		
57. Are flat bottom pots and pans used?		
58. Is a timer used to avoid over-cooking?		
59. Are pots covered during cooking?		
60. Is as little water as possible used during cooking?		
61. Is the heated dry cycle on the dishwasher not used?		
Clothing		
62. Does your family dress warmer in cool weather to avoid mechanical heating?		
63. Does your family dress cooler in warm weather to avoid mechanical cooling?		
64. Are clothes washed only when there is a full load?		
65. When washing, is cold or warm water used when possible?		
66. Are clothes line dried when possible?		
67. Are most of your family's clothes wash-and-wear, permanent press to avoid dry cleaning and ironing?		
68. Are clothes always rinsed with cold water?		
69. Is the washer located near the water heater?		
70. Is the dryer lint screen cleaned after each load?		

Personal Care

	yes	no
71. Do the members of your family take short showers or use only small amounts of water for tub baths?		
72. Are all water faucets repaired and not leaking?		
73. For washing, shaving or make-up is the lavatory filled rather than allowing water to run?		

Entertainment

74. Are entertainment devices turned off when not in use?		
75. Do members of your family try to entertain themselves rather than rely on devices?		

--If you answered with 65 or more yes's, you are truly an energy conserver and will make a good conservation advocate.

--If you answered with 55 to 65 yes's, you are energy conscious but lack will-power or drive.

--If you answered with 45 to 54 yes's, you are wasting energy but with minor changes could make a conserver.

--If you answered with 35 to 44 yes's, you are an energy waster and should make an all-out effort to reform!

--If you answered with less than 35 yes's, you are making an effort to waste energy and should consider the long range and immediate effects!!

Suggestions:

1. Distribute these checklists school-wide.
2. Try a before and after approach to using the checklist. Check before your conserving effort and after.
3. Survey students to see if their families are generally conservative or not.

PHYSICAL
SOCIAL
CULTURAL
ECONOMIC
TECHNOL-
OGY
GOVERNMENT
WORLD
CONSUMERS

DISCUSSION GUIDE - SYSTEMS DEFINED AND EXPLAINED

A system is defined as a coordinated set of parts for accomplishing goals. It is a set of things or parts forming a whole. We commonly refer to digestive systems, railroad systems, heating systems, and nervous systems, for example.

A system is interrelated elements or parts having a boundary and functional unit within a larger system (Deacon and Firebaugh 1975). It is possible to study residential energy use using a systems approach? See what you think of the idea.

Imagine a boundary placed around consumers or family members to separate and designate the family as the focus of interest in this study of energy use. Families interact with other systems in the use of energy. No family can exist long without resources. No family remains free from outside demands. Government, economics, technology, the physical environment, the world situation and our society all influence the consumer's energy use.

With these components identified, the learner should be better able to understand the complexity of the energy situation.

The following may be used to describe the systems interacting with families/consumers.

1. The physical environment includes the natural resources which are available, for example.

2. Technology is knowledge organized for useful purposes. Technological developments range from freeze-dried food to take on camping trips to transistorized radios which have changed our lives.

3. The governmental system is held responsible for achieving society's goals through policies, law, regulations and the means to implement and enforce them. This school exists partially because of our government regulation that everyone should have the opportunity for an education.

4. Economic People work and give their time for wages or salaries. This is the family members' exchange with the general economy. We buy items (goods and services) with the money we make.

5. Culture reflects the customs of a society and provides guidelines for future behavior. Cultural values and patterns are learned primarily in our families.

6. Americans do not live in isolation. Other countries influence our lives and the United States has an impact on world affairs.

DISCUSSION GUIDE - SYSTEMS INFLUENCING FAMILIES

Examples

1. Suppose someone wanted to build a house that was dome-shaped or totally underground in a traditional neighborhood. What would provide the most influence on whether or not the home could be built?
   Sociocultural - Would the neighbors be accepting?
   Government - Housing codes may prohibit building the house.

2. Suppose you were building a home and the walls did not have enough insulation placed in them to meet building codes. The home would be ineligible for an FHA (Farmers Home Administration) loan.

3. A developer was ready to build an apartment complex and found that natural gas was not available at the location he/she had selected. By which system would the limit be made? (Physical environment)

4. A contractor wanted to use solar energy on a 54-unit apartment building. He/she planned to have a lot of window glass on the south facing walls and relatively little window area on the north sides. The loan companies did not want to loan money on an apartment with a non-traditional heating system. Which system is influencing the ultimate consumers, the future apartment dwellers? (socio-cultural, economic)

5. Suppose you were buying a mobile home and wanted to install solar collectors on the roof. Do you think it would be easy to find a way? Which would influence this situation? (Available technology)

6. Oil prices are raised because of the involvement of the United States in the affairs of other nations. (World affairs)

A NEW START THE NATIONAL ENERGY ACT

U.S. Department of Energy

A New Start

"Today we can rightfully claim that we have a conscious national policy for dealing with the energy problems of the present and also to help us deal with them in the future."

Those were the words of President Carter at the signing on November 9, 1978, of the most comprehensive energy legislation the Nation has yet enacted.

The National Energy Act is a significant first step toward assuring the adequacy of domestic energy supplies and the health and vitality of our economy.

As President Carter said after passage of the Act, "We have declared to ourselves and to the world our intent to control our use of energy, and thereby to control our own destiny as a Nation."

Underscoring its importance are estimates indicating that full implementation will save the Nation at least 2.5 to 3 million barrels of oil imports a day by 1985 over what otherwise would be the case. And for each million barrels of oil per day not imported, the United States saves at least $5 billion a year in overseas payments.

Energy Secretary James R. Schlesinger, whose department is administering the Act, said its purpose "is to put into place a policy framework for decreasing oil imports by:

- replacing oil and gas with abundant domestic fuels in industry and electric utilities, such as coal,
- reducing energy demand through improved efficiency,
- increasing production of conventional sources of domestic energy through more rational pricing policies, and
- building a base for the development of solar and renewable energy sources."

When President Carter submitted to Congress the Plan on which the National Energy Act is based, he said, "There is an energy challenge to be met. I have faith that meeting this challenge will make our lives more satisfying. We can rediscover the ingenuity and the efficiency which have made our Nation prosper, rather than deepening our dependence on insecure imports and increasingly expensive conventional energy supplies."

THE CHALLENGE

The President mentioned "meeting a challenge." What challenge? Isn't there plenty of energy, plent. of oil? We read about "oil gluts," and about "significant new oil discoveries." Why is there a challenge?

There is indeed an energy challenge to be met, a transition to undergo, an oil problem to be solved. Last year, this country used energy at a rate equivalent to 37 million barrels of oil a day. Almost *half* of that energy came from oil itself. And almost half of that oil, *a quarter of our total energy consumption*, was imported. Each and every hour, the United States imports an average of almost 400,000 barrels of oil, an unsustainable rate.

THE REALITIES

The National Energy Act is based on recognition of four realities:

1. World oil production will peak sometime during the next 15 years, while world oil demand will continue to grow. Exactly when this prospective supply-demand gap will occur depends on the willingness and ability of the Organization of Petroleum Exporting Countries (OPEC) to produce, and on the willingness and ability of the United States and other nations to limit demand. This gap is expected to occur in the mid- to late 1980s, but could occur sooner.
2. Even if adequate oil supplies were available in the mid- to late 1980s, the United States could not afford to pay for them. The balance of payments outflow would have fiscal and economic effects that would be increasingly unacceptable, socially and politically, domestically and internationally.
3. Even if these economic, political, and social impacts could somehow be minimized, foreign policy and strategic and national security implications of increased oil import dependency would be intolerable.
4. The world oil problem *will* be resolved, either *uncontrollably*, through severe economic shocks to national economies, or *controllably*, through concerted early action to ease the transition that must be made to more abundant sources.

So we have no alternative; we *must* reduce dependence on the oil we're importing, and we must use the oil we consume more efficiently. To achieve this goal, the President asked for, and Congress gave him, with some modifications, energy legislation covering the following areas:

Energy Conservation
Coal Conversion
Utility Rate Reform
Natural Gas Pricing
Tax Credits for Energy-Saving Investments

Brief descriptions of each of these portions of the Act are given below.

CONSERVATION: Highlights of the *National Energy Conservation Act of 1978*

The reduction of energy demand through efficiency is central to the objectives of the National Energy Act. Conservation provides each member of the public, every family and business and industry, a chance to take direct action to reduce their own energy bills and, consequently, the amount of dollars spent overseas to pay for imported oil.

Benjamin Franklin once said, "A penny saved is a penny earned." Today, it can be said that: "A barrel of oil saved is a barrel of oil earned, and then some." It may cost a little to save a barrel of oil, for example, by insulating your home. It may cost nothing at all, for example, by turning out unneeded lights. The average cost of conserving a barrel of oil is estimated at less than $7 a barrel. But to *buy* that barrel of oil from overseas would cost $14 or $15 now, and $16 or more by the end of 1979. Synthetic oil made from coal might cost the equivalent of $25 a barrel, or more.

So in a very real sense, conservation is our *best, cheapest,* and *quickest* source of oil supply. In fact, our wasteful and inefficient use of energy in the past gives us broad opportunities to conserve. "We must," Secretary Schlesinger said, "avoid increased dependence on oil. . . . We must achieve a higher degree of fuel efficiency. We must learn to conserve."

"READING FOR CURRENT PERIODICAL",25

It's a great system

(pass it on.)

The System

Knowledge of the American incentive market system and how it functions should provide us with a better understanding of how our society has grown during the last two-hundred years. Let's review the system and our society as a whole, a nation encompassing over 200 million people at home on their continental land area, yet reaching out through trade, investment, transportation, communication, and other activities to touch and affect many millions of other people around the globe. Certainly ours is an extraordinary society, marked by achievements and remarkable willingness to undertake formidable tasks.

It is the most active and productive society of our time--indeed of any other time known to history. Each year the annual production of goods and services by the American people--the largest national output in the world--approximately matches the combined total production of all other industrially advanced nations, excluding those in the Soviet sphere of influence. Each year the productivity of our people, made possible by our labor, ingenuity, tools, and economic organization, enables the majority to enjoy the highest living standard the world has ever seen.

Yet there are limits to the abilities of even so productive a society as this one to satisfy the wants of its members. Increasingly, more people have come to realize that many of us have expected more from our economy than it is able to produce--at least in any short time period. Our productive capacity is limited in relation to our wants and resources, so we must make choices which ensure that our most important needs--food, shelter, clothing, transportation, health, and education--are provided for first. This is the economic problem of scarcity which every society faces, and ours is no exception.

In fact, every society must organize an effective system for meeting the needs of its members, which determines:

- What and how much will be produced?
- How, when, and where will it be produced?
- How and to whom will it be distributed?

How are such decisions made in our society? Who organizes the activity to carry them out--and how?

The Market System

Much of our economy is based on a voluntary competitive system of prices and markets. We can best illustrate this by thinking about a typical business transaction. A person goes to the supermarket to buy groceries. At the bakery counter, many types of bread are available. One is selected, and ultimately a cashier totals the purchases at the checkout counter where they are paid for.

Neither the store manager who sold the bread, nor the bakery that made it, nor the mill that supplied the flour, nor the farmer who grew the wheat knew who would buy the final product in the chain of transactions.

Organization

First of all, businesses determined the "market" for their goods. They knew approximately what quantity could be sold. They knew there was a demand for what they had to sell. Raw materials were ordered, machinery assembled, and workers employed. While they did not necessarily know the buyers personally, they understood the buyers needs and provided a product to meet those needs. Experience indicated the approximate price customers would be willing to pay.

But the whole chain of transactions was voluntary. Together they brought about an organization of actions which wound up with a new loaf of bread in the buyer's kitchen. Each day millions of independent production, distribution, and consumption value judgement decisions combine to provide our market with an astounding variety of goods, services, and prices.

In summary, suppliers sell the kinds of goods and services they think buyers will want, at prices which reward them for their services. In other words, the goods which suppliers bring to market are intended to match buyers' wants. Supply is created to meet demand.

The Consumer is Boss

The consumer, the buyer of end products, has a powerful voice in this system. Ultimately the consumer's power of choice--the decision to buy or not to buy and to choose between competing products--is decisive in guiding the market system. This power of choice means that the consumer gives the orders (demand) which ultimately confirm or reject the business decisions that brought the supply of goods to market.

Consumer choices, reflected in the way income is spent, help determine the worth, value, or price of goods and services, and so guide production. If consumers buy more automobiles, production will be increased. If they buy fewer, production will be cut back or an alternate method will be developed to lower production costs. Nothing will be produced very long that doesn't sell. So production of most-wanted items rises and that of less-wanted items falls. Consumer dollars vote for some products and against others. Increases, decreases, or changes in production are made in response to these signals.

The Role of Business

Before goods and services can be supplied, production must be organized. Productivity, which contributes to our material welfare, is based on three factors:

1. **Land**, which describes the public and private ownership of natural resources, whose form, condition, and location are changed by
2. **Labor**, which includes the employment of, and reward for, all types of physical and mental human effort, and
3. **Capital**, which consists of the tools, plants, and equipment used to produce and distribute goods and services.

Labor, capital, and other productive resources must be brought together and combined efficiently to create goods and services people need and will buy. In the market economy, this is the job of business firms and the people who run them. Each business decides what and how to produce and, generally, to what group of people it will try to sell its products.

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Prices and Profits Guide Market Decisions and Create Competition

Meanwhile, markets are constantly changing. Consumer demand changes. Prices and uses of the means of production also shift in response. Producers in business and industry must react to these changes promptly, or their decisions will be rejected by the market (customers), and they will have a loss. Unless they change they can go out of business.

Market activity expresses its competitive pressures largely through the pricing of goods and services. Well informed consumers intensify these pressures through careful shopping for the best values. Every day, under the pressure of market forces, producers compete to supply consumer needs. When one producer finds and adopts a cost-reducing method, he can add to his profit or sell at lower cost than his rivals and gain a financial or marketing advantage. Competitors must quickly match this price through innovation, quality improvement, or better service or they will lose sales.

Because of competitive pricing, customers tend to shift from less successful to more successful firms. High-cost or low-quality firms lose customers first. They also incur losses--the negative side of profits--which signal them to make changes. If they cannot reduce costs or improve quality, they must switch to new products or go out of business. Price is the major factor in determining what goods and services will be produced and how much will be consumed.

The Incentives of Profit

Successful firms make profits. Their earnings pay for capital or borrowed funds invested in the business, as well as for the risk-taking and the services provided. Profit has a double function. First, it rewards successful enterprises. Second, it constitutes the incentive to improve goods or services. Profit spurs efficiency and growth. Rising profits signal that buyers want more of such products and are willing to pay for them. Falling profits or losses signal that costs are too high in relation to buyers' willingness or ability to pay.

Profit is a powerful stimulus to producers. The absence of profit--or the presence of its opposite, loss--also has a social function. Occasional losses spur producers to greater efficiency. Steady losses reduce or eliminate production of less wanted goods. They may also eliminate inefficient producers.

In the last few years, average profits of U.S. businesses have ranged from approximately three cents to five cents on each sales dollar. These are remarkably narrow margins on which to base the operations of so large and complex a market economy. Yet they suffice to allocate productive resources to the business activities that produce what people want most--as shown by what they buy. Moreover, it is a very modest proportion of the total income created by production. Yet these incentives have helped create a voluntary organization of human effort and coordinated action of unparalleled productivity.

Interaction of Political and Economic Systems

Market processes do not operate in a vacuum, however. The main, privately operated sector of our economic system works within a framework of law and public administration established through our political processes, which are responsive to different kinds of decision-making.

Because people, through their political processes, choose legislators who enact laws and provide for their enforcement, they are part of a decision-making system that can enhance, restrict, or nullify the working of market forces. Producers must respond to these changes or suffer the consequences. Thus, political decisions can affect supply, pricing, profit, and cost relationships and thereby distort the market signals which guide producers' and consumers' actions.

Both supply and demand are responsive to price. Economists talk about supply at any given price and what supply might be at some other price. They talk about demand in the same way. Politicians and other non-economists tend to talk about what future supply and demand might be at today's price. As a result, they are always finding gaps between supply and demand. When the projected supply exceeds projected demand, they usually prefer to curtail production in some artificial way. When demand exceeds supply, they usually prefer to correct it through rationing and allocation.

Normally, the free market could solve problems of scarcity. Shortages could be eliminated if prices motivate the customer to consume less and the producer to provide more. This in turn could result in a new product or process that is better and costs less. For the economist who believes in the price mechanism, there can be no lasting gap between supply and demand, only temporary ones. The economist knows that--given a little patience--the price mechanism will establish a new balance.

The government's major source of funds is from the people. Everything the government provides, it must tax, borrow or otherwise obtain from the income or property of people. When government spends more than it receives, the resulting deficit is a major cause of inflation. Chronic deficits, and imbalances in supply and demand are primary causes of inflation. Inflation reduces the value of all material wealth.

Our nation's wealth is based on private enterprise, competition, and monetary reward for productive service and thrift. Business brings capital, natural resources and labor together to generate material wealth, and hence, the money that repays investors, keeps people employed, increases productivity and efficiency, and pays the taxes that sustain government.

If the productive sector is prevented from making the profits required to buy new production tools, create new jobs, and embark on the research essential to meeting future public needs . . . then neither government nor competitive enterprise will be able to meet its respective responsibilities to society.

The Choice

The American people seek clearer perspectives on the progress and direction their society will take. Whatever they undertake--individually, in small or large groups, or as a nation--will greatly depend on the understanding they apply to the economic means through which they seek their goals.

Our American system, which has surmounted great challenges in the past, will continue to serve us well in the future if we understand its working and exercise our very considerable powers of individual choice in the light of that understanding. You vote with your dollar everytime you purchase goods or services. You vote for representation at every election, and you vote for legislative action every time you contact your legislators and express your opinions on key issues.

We have a great system--pass it on!

"READING FROM CURRENT PERIODICAL"

By Leonard Gross

Is Less More?[11]

The following superlative is offered after considerable thought: Americans are, or will shortly be, in the process of making the most fundamental adjustment they have ever had to make. If this adjustment concerned solely their standard of living, the superlative would not be valid. What makes it so is that this is the first time Americans have ever had to change the *assumptions* about the manner in which they live.

There have been times of sacrifice before, particularly during wars, but the assumption was that times would be "good" again when the emergency ended. Today, however, economic factors are such that the prudent American must adjust to the likelihood that material life may never be the same again.

This country is in the process of discovering that it can no longer afford the big life. That is the downstream meaning of our present economic turmoil. From whatever area you approach the problem, be it resources, inflation, population or politics, the prospect remains the same. Solutions will necessarily require permanent alterations in the size and scope of our activities, possessions and dreams.

Already, the broadly shared dream of upper-middle-class affluence has passed the average dreamer by. He figured that if he ever earned $[illegible],000 a year, he'd have it made. Today, he's got the salary, but he's also got hobbling debts. Gains in real income for the middle class have been tiny, there's almost no upward mobility any longer. Aspirations to send children to college have been tempered by the immense cost and inability of degree holders to find employment.

LOOKING BLEAKLY AHEAD

Call it "middle-class discontent." It's demonstrably higher now than at any time in recent history. It will not lessen in our lifetime, not, at least, as a consequence of improved conditions. The cost of land will not diminish. The cost of money may diminish somewhat, but not to the levels that enabled millions of Americans to build their own homes in the years after the second world war. The value of the dollar will not increase. The cost of goods and services will not diminish, if only because the cost of fuel, a major production factor in every economic sector, will never return to previous levels. Populations will increase here and abroad, compounding problems of employment, education and maintenance.

It all sounds pretty bleak. And yet, and yet. Inherent in the problem is a stunning resolution—nothing less than a change in the values by which we measure life. Because there *is* one variable in all this picture: the individual. He can diminish his discontent by reordering his priorities.

NO MORE FIRST CLASS

What happens to a society when its members have less purchasing power is already beginning to be apparent. There will be practical changes in the way people live: smaller, less elaborate houses, fewer single-family dwellings, more cluster zoning, more condominiums, better use of land so as to provide more recreation near the home. Because travel will be so expensive, the environment near the home will receive greater attention.

With the price of food so high, discretionary income will be diverted to supplement food budgets. That means less money for entertainment and an increasing reliance on the home as the family entertainment center. Such vacations as will be possible will change their nature. Vacation clubs, little known in the United States but enormously successful in Europe, will come into vogue. The Club Méditerranée, originator of the concept and prototype for other clubs, has already developed an American market.

Railroads work in Europe because Europeans use railroads. And because they work, Europeans can board a train in the evening and be at their skiing station early the next morning after an inexpensive and acceptable night in a couchette. When Americans can no longer afford long trips in automobiles or airplanes, they will return to the railroads, the least expensive and the least environment-punishing form of mass transportation.

A subtle strain runs through these eventualities. Without neglecting the individual, we address ourselves to the common good. Everyone isn't vying for first cabin any longer; we're content to get there more modestly—and happy in the knowledge that our arrival is assured. The new American dream will esteem "small" more than "big." The trend to smaller cars, recently made concrete by the General Motors announcement that its new models will be an average of 700 pounds lighter, is thus not simply a response to the fuel shortage. Eventually, it becomes an expression of taste.

"Less is more" is a phrase attributed to Mies van der Rohe, the German architect, a leader of the Bauhaus group and pivotal force in the field of modern design. That single statement crystallized the philosophy of contemporary architecture and design—to do away with frilly styles. Would a life-style that did away with unnecessary baggage achieve the same simplicity and purity? Every week, it seems, I hear of one more American who thinks so. All were successful. All had made it to the top and then decided that the prize hadn't been worth the trip. "Can you imagine spending your life getting to a place and then finding you didn't want to be there?" one of them asked rhetorically.

A NEW PREMISE

Economic necessity will do more to change styles of life than any previous factor. Moral imperatives don't embody an imperative for change. But when you can no longer afford the life you're living, or the life you can buy for what you earn becomes unacceptable, *then* you're motivated to change.

Since our inception, the American Premise has stated that happiness lay ahead, in the bigger job, the bigger home, the bigger life. The larger implication of our new economic reality is nothing less than a rejection of that premise, with profound consequences in terms of social objectives and how they're expressed commercially. That many Americans will continue to grab for the brass ring while others are letting go in no way invalidates the premise. Facts in apparent contradiction can be simultaneously true.

Gross is a California-based writer whose latest book is "Total Fitness: In 30 Minutes a Week," written with physiologist Laurence E. Morehouse.

100 WATT PORCH LIGHT

Avg. operating wattage	No. of uses/year	x	Time/use	=	Hours/year	%Time actually on	Watts/year = hr/yr x watts
100	365 (everyday)	x	4 hours (each day)	=	1,460	100	146,000

divide by 1,000 for KWH

$$\frac{146{,}000}{1{,}000} = 146 \text{ KWH}$$

at 5 cent/KWH = $7.30/year

ACTIVITY G — METER READING[26]

OBJECTIVE: TO DEMONSTRATE HOW TO READ ELECTRIC AND GAS METERS, AND HOW TO DETERMINE CONSUMPTION OVER A PERIOD OF TIME.

In order to determine the effectiveness of your energy-conservation efforts you must be able to tell how much energy is being consumed at your house. The easiest way to do this is by taking meter readings. Electric and gas meters give the total, or cumulative, energy consumption. They operate much like the odometer on a car. You must compare beginning and end readings to find out how much energy your family used over a given period of time (one day, one week, one month). For example, if your meter read 35721 kilowatt-hours on Monday morning and 35731 on Tuesday morning, it means your home consumed 10 kilowatt-hours of electricity for that day or 24-hour period.

Most electric meters have five dials organized from right to left: the rightmost indicates kilowatt-hours; the next dial, tens of kilowatt-hours; then hundreds; and so on. But the dials alternately rotate clockwise and counterclockwise. You should record the digit the indicator has just passed. Study the illustrations and readings below:

READING = 35721

READING = 66190

The dials of a gas meter are much like that of an electric meter except that there are usually only four dials with markings representing 100 cubic feet on the rightmost dial. In the illustration on the next page, the reading of 4846 represents 484,600 cubic feet of gas.

READING=4846

If, after one day, the reading were 4876, then the consumption that 24-hour period would have been 3,000 cubic feet of gas.

$$\begin{array}{r} 487600 \\ -484600 \\ \hline 3000 \end{array}$$ cubic feet of gas

Now check your meter and record your findings:

Initial Reading_____
Final Reading_____

Consumption for designated
time period_____

Now institute one or several energy-conserving practices (reset thermostat; clean filters; cut down on use of lights, appliances, TV; take short showers) and record your findings: (Use the same time period as before)

Initial Reading_____
Energy Conservation Measures Instituted

_____

_____

_____

Final Reading_____
Consumption for designated
time period_____

Was there a reduction in consumption when conservation was practiced?

Suggestions:

1. Use a time period of at least a week.
2. Ask your local Utilities for information or demonstrations.

ACTIVITY H THERMOSTAT SETBACK [26]

OBJECTIVE: TO DEMONSTRATE THE EFFECT THERMOSTAT SETBACK HAS ON ENERGY CONSUMPTION.

Now that you can read your meter (Activity G), you can investigate the effects of thermostat setback on the energy consumption at your residence. During the cooling season, thermostats should be set up to 78°F to reduce the use of mechanical air conditioning and during the heating season, set down to 65°F. For additional savings, the thermostat can be set back to 60°F during the night. The effect of these thermostat setbacks will vary from residence to residence, but should be significant.

To test the impact of thermostat setback at your home, first determine the weekly consumption of energy prior to the setback. Read your gas, oil, or electric meter one week before the setback and read it a second time exactly seven days (to the hour) later.

For example:

First Reading	Second Reading
Meter Reading: 14276 kwh	Meter Reading: 15101 kwh
Date: 9/8/77	Date: 9/15/77
Time: 8:00 a.m.	Time: 8:00 a.m.

The energy consumed by the example home for the week was 925 kwh (15101 kwh-14276 kwh = 925 kwh)

Immediately after the second reading set back the thermostat 5°F lower if heating and 5°F higher if cooling. Then take a third meter reading exactly seven days later.

For example:

Third Reading
Meter Reading: 15897 kwh
Date: 9/22/77
Time: 8:00 a.m.

The energy consumed by the example home for the week with the set back is 796 kwh. To determine the possible savings, find the difference between the first week's consumption and the setback week's consumption.

Using the example home:

925 kwh - 796 kwh = 129 kwh

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Now try the test at your residence.

First Reading	Second Reading	Third Reading
Meter Reading: _____	Meter Reading: _____	Meter Reading: _____
Date: _____	Date: _____	Date: _____
Time: _____	Time: _____	Time: _____

First week's consumption:

_____ - _____ = _____

meter reading 2 meter reading 1 consumption

Setback week's consumption:

_____ - _____ = _____

meter reading 3 meter reading 2 consumption

Savings

_____ - _____ = _____

First week's consumption Setback week's consumption = savings

Questions:

1. Why is it better to use a week's consumption for comparison rather than a day or an hour?

2. What could be possible reasons for finding no savings or possibly an increase in consumption during the week with the setback?

3. How much money could be saved in a year if you could realize the savings you found (if you found one) during the setback week?

Suggestions:

1. Do this investigation when mechanical heating or cooling is certain to be needed.

2. Refer to Activity G for a more detailed description of meter reading for electricity, oil, or gas.

3. Make certain no one adjusts the thermostat during the two weeks of the investigation.

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ACTIVITY I — HOT WATER AUDIT [26]

OBJECTIVE: TO DEMONSTRATE A FAMILY'S HOT WATER CONSUMPTION AND POSSIBLE CONSERVATION MEASURES.

The major uses of hot water in the home are for bathing and laundry. Use the data sheet provided to estimate your family's hot water consumption for a week.

Task	Number of times/week	Multiplier (in gallons)	Quantity of Hot Water (in gallons)
laundry loads			
tub baths		15	
showers		25	
dishwasher loads		20	
washing dishes by hand		10	
		5	
		Total--	

Tally the number of times per week the task using hot water occurs. Then multiply the number of times by the multiplier provided. The multiplier is the average amount of hot water required for the task. The resulting value is the quantity of hot water consumed for the task. Then add the quantities for each task to arrive at an estimate of the hot water your family uses in one week. (The average household uses about 350 gallons of hot water per week.)

You can now approximate the energy required to supply this quantity of hot water.

_____ gallons x 2.45 watt-hours/gal. = _____ watt-hour
quantity of water

If you use _____ gallons per week, you use approximately 52 times that per year or _____ gallons.

Calculate the energy cost for a year's consumption:

_____ gallons x 2.45 watt-hours/gal. = _____ watt-hours
quantity of water

This is _____ kwh for one year (just move the decimal 3 places to the left). Find out the rate in your area for electricity per kwh and determine the cost of one year's hot water consumption.

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_____ kwh	x	____ cents	=	$ _____
yearly energy consumption for hot water		rate kwh		

How could you save money and energy for hot water at your house?

Some things to look for if your hot water consumption is high:

1. Check your water heater's thermostat--it should be set at 140°F or less.

2. Check for leaks.

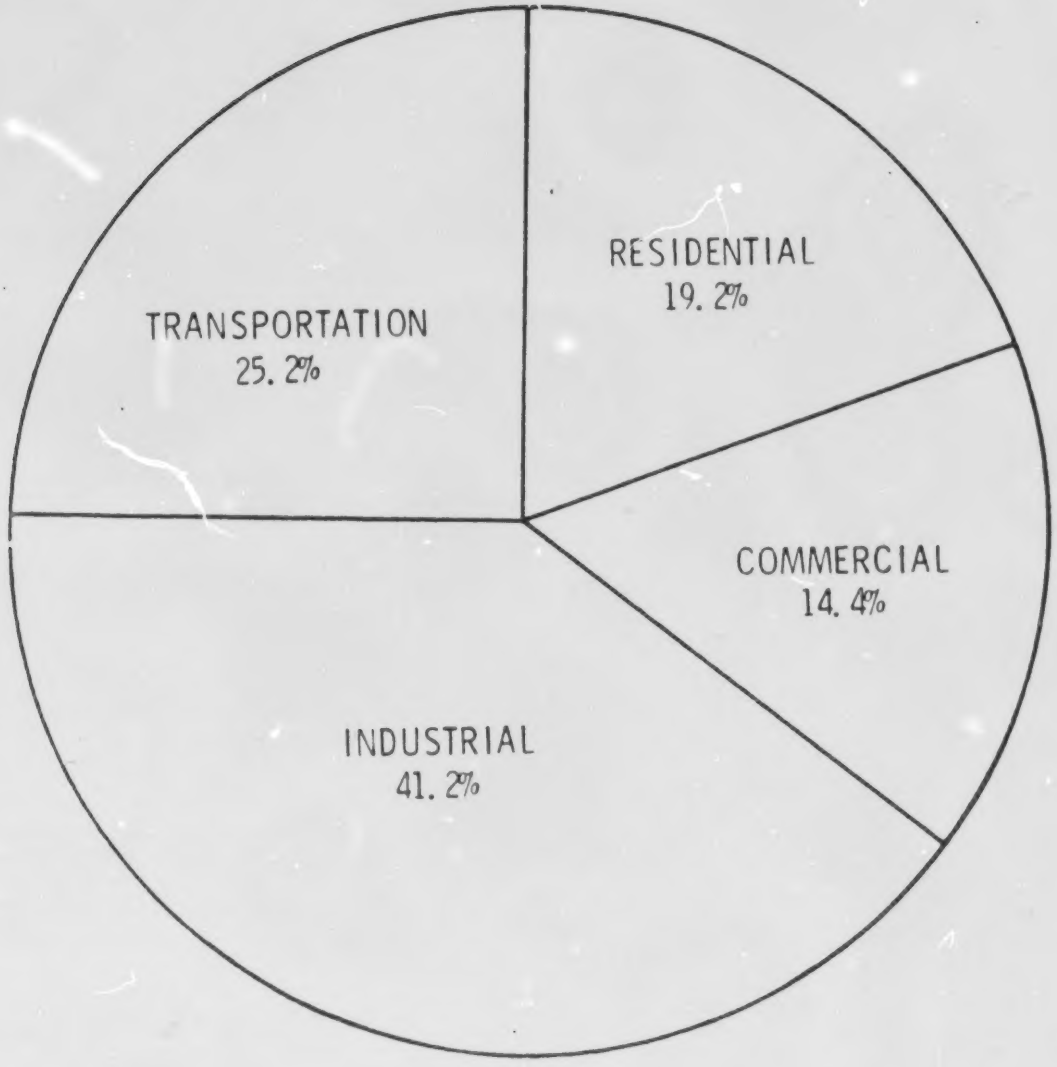
3. Are the hot water pipes insulated?

Suggestions:

1. Students should bring in their tallies of frequencies from home and do the calculations as a class.

2. All of the figures and calculations in this activity are based on averages and estimates and do not indicate actual hot water use. However, by checking appliance manuals and timing showers (approximately 8 gallons of water is used per minute), a more accurate consumption figure could be obtained.

"ENERGY USE IN THE UNITED STATES"



ANNUAL ENERGY REQUIREMENTS OF ELECTRIC HOUSEHOLD APPLIANCES UNDER NORMAL USE [26]

When using these figures for projections, such factors as the size of the specific appliance, the geographic area of use and individual usage should be taken into consideration. Note that wattages are not additive since all units are normally not in operation at the same time.

Appliance	Average Wattage	Est. kwh Consumed Annually
FOOD PREPARATION		
Blender	386	15
Broiler	1,436	100
Carving Knife	92	8
Coffee Maker	894	106
Deep Fryer	1,448	83
Dishwasher	1,201	363
Egg Cooker	516	14
Frying Pan	1,196	186
Hot Plate	1,257	90
Mixer	127	13
Oven, Microwave (only)	1,450	190
Range		
with oven	12,200	1,175
with self-cleaning oven	12,200	1,205
Roaster	1,333	205
Sandwich Grill	1,161	33
Toaster	1,146	39
Trash Compactor	400	50
Waffle Iron	1,116	22
Waste Disposer	445	30
FOOD PRESERVATION		
Freezer (15 cu. ft.)	341	1,195
Freezer (frostless 15 cu. ft.)	440	1,761
Refrigerator (12 cu. ft.)	241	728
Refrigerator (frostless 12 cu ft)	321	1,217
Refrigerator/Freezer (14 cu. ft)	326	1,136
(Frostless 14 cu.ft)	615	1,829

APPENDIX C (Continued)

Appliance	Average Wattage	Est. kwh Consumed Annually
LAUNDRY		
Clothes Dryer	4,856	993
Iron (hand)	1,008	144
Washing Machine (automatic)	512	103
Washing Machine (non-automatic)	286	76
Water Heater	2,475	4,219
Water Heater (quick recovery)	4,474	4,811
COMFORT CONDITIONING		
Air Cleaner	50	216
Air Conditioner (room)	860	860*
Bed Covering	177	147
Dehumidifier	257	377
Fan (attic)	370	291
Fan (circulating)	88	43
Fan (rollaway)	171	138
Fan (window)	200	170
Heater (portable)	1,322	176
Heating Pad	65	10
Humidifier	177	163
HEALTH & BEAUTY		
Germicidal Lamp	20	141
Hair Dryer	381	14
Heat Lamp (infrared)	250	13
Shaver	14	1.8
Sun Lamp	279	16
Tooth Brush	7	0.5
Vibrator	40	2
HOME ENTERTAINMENT		
Radio	71	86
Radio/Record Player	109	109
Television		
black & white tube type	160	350
black & white solid state	55	120
color tube type	300	660
color solid state	200	440

*Based on 1000 hours of operation per year. This figure will vary widely depending on area and specific size of unit.

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APPENDIX C (Continued)

Appliance	Average Wattage	Est. kwh Consumed Annually
HOUSEWARES		
Clock	2	17
Floor Polisher	305	15
Sewing Machine	75	11
Vacuum Cleaner	630	46

SOURCE: Electric Energy Association

ED. NOTE: The highest wattage appliances are not necessarily the one which consume the most energy in a year but that ''continuous'' operation versus ''intermittent'' operation has a major effect on the total energy consumption in a year. Note also that appliances producing heat have higher wattages than other appliances.

ACTIVITY P ENERGY CONSUMPTION OF APPLIANCES [26]

OBJECTIVE: TO DETERMINE THE ENERGY CONSUMPTION OF HOME APPLIANCES AND EQUIPMENT

If you were to list all the energy-using appliances and equipment in your home, you would see why it is estimated that a well-equipped home consumes as much as 35,000,000 BTU's of energy each year to operate appliances and equipment. Much of this energy is wasted and offers a great opportunity for energy conservation.

The first step toward conservation is to gain a better perspective and understanding of the energy consumption of each appliance or piece of equipment. This is very easy to do. Just find the electrical "ratings" information on the back or bottom of the appliance or piece of equipment. You will see several numbers much like those shown below (from the base of a blender):

For Service Specify No. 850-14A

Model 850
Series
Volts 120
Freq. 25-60 cycle
Watts 960 A.C. only

U_L

JX

The key number is the wattage rating, 960 watts in the example above. The wattage is an indicator of the kilowatt-hours of energy used per hour of operation of the appliance. It requires 1 kilowatt-hour per hour of operation for 1000 watts. In the example above:

Appliance: blender

960 watts ÷ 1000 $\frac{\text{watts}}{\text{kilowatt-hr per hr of operation}}$ = 0.96 kilowatt-hour

(Note: You can divide by 1000 by moving the decimal 3 digits to the left.) Now you try it.

Appliance: _____

_____ watts ÷ 1000 $\frac{\text{watts}}{\text{kwt-hr per hr of operation}}$ = _____ kilowatt-hr.

217

Appliance:_____

_____watts ÷ 1000 watts / kwt-hr per hr of operation = _____kilowatt-hr.

Appliance:_____

_____watts ÷ 1000 watts / kwt-hr per hr of operation = _____kilowatt-hr.

Using the table below you can see what the appliances you checked consume in equivalents of oil or coal.

Electrical Appliance Energy Table

Appliance Wattage Rating	Kilowatt-Hours of Energy Used per Hour	Ounces of oil Burned per Hour	Ounces of coal Burned per Hour
10	0.01	0.1	0.13
25	0.025	0.25	0.33
40	0.04	0.4	0.5
60	0.06	0.6	0.8
100	0.1	1	1.33
150	0.15	1.5	2
200	0.2	2	2.66
300	0.3	3	4
500	0.5	5	6.66
750	0.75	7.5	10
1000	1	10	13.33
1500	1.5	15	20
2000	2	20	26.66
5000	5	50	66.66
10000	10	100	133.33

Suggestions:

1. Do not try to move large appliances by yourself to obtain wattage ratings.
2. Seek permission and aid from parents to locate wattage rating information.
3. The teacher may use appliances in the home economics laboratory as examples.
4. Students may be assigned different equipment to insure a wide range and thorough investigation of household appliances.
5. Answers in terms of kilowatt-hours of energy required may be expanded to annual use by determining daily or weekly use and multiplying.

RESIDENTIAL ENERGY USE

END USE	PERCENT OF TOTAL
SPACE HEATING	57.5
WATER HEATING	14.9
COOKING	6.0
REFRIGERATION	5.5
AIR CONDITIONING	3.7
TELEVISION	3.0
CLOTHES DRYING	1.7
FOOD FREEZING	1.9
OTHER	5.8
TOTAL	100.0

SCE&G

Residential Electric Service Charges

On April 1, 1982, the South Carolina Public Service Commission approved a portion of the increase in charges for electric service originally placed into effect by South Carolina Electric & Gas Company in April 1981.

The PSC ordered the amount collected but not approved to be refunded to customers with 9% interest. Your refund with interest, if applicable, has been subtracted from your current bill.

Shown here is the approved rate for standard residential electric service currently being charged.

RATE 8

	RATE PER MONTH	
	SUMMER (Billing Months June - September)	WINTER (Billing Months October - May)
Basic Facilities Charge	$6.00	$6.00
Plus Energy Charge:		
First 800 KWHs at	$.05596 per KWH	$.05596 per KWH
Excess over 800 KWHs at	$.06191 per KWH	$.04955 per KWH

184A

REa 582

SCE&G

Return in envelope with your payment or leave at your local SCE&G office.

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Technical/Conservation Services (J-41)

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New Optional Rates Available

The Public Service Commission, in its April ruling, also has approved two new residential electric rates, developed and requested by South Carolina Electric & Gas Company. The two new rates are the Residential Energy Conservation Rate (REC) and the Residential Time-of-Use Rate (RTU). A description of each of the new rates is provided here.

It is important that residential electric customers of South Carolina Electric & Gas Company understand that all residential customers are currently on our standard residential Rate 8 and will remain on this rate unless they request a change and meet the terms and conditions for either of the new rates.

Residential Energy Conservation Rate (REC)

This new rate is designed to give residential electric customers, whose homes meet stringent energy conservation requirements, a lower rate that could mean a 2 to 9 percent savings over our regular residential Rate 8 depending upon the usage level. Customers requesting this rate must have their home certified by an SCE&G Energy Services Representative as meeting the REC requirements.

The requirements for qualifying for this rate are higher than any program or certification used by South Carolina Electric & Gas Company in the past. They include substantial insulation in ceilings, walls and floors as well as double glass or storm windows, sufficient attic ventilation, weatherstripping and other requirements. A complete description of the rate and its requirements can be secured at any SCE&G local office or by returning the form attached to this folder.

Residential Time Of Use Rate (RTU)

(Columbia and Charleston metropolitan areas only)

The second new residential rate approved by the PSC is the Residential Time of Use Rate (RTU). It is initially available only to residential electric customers of SCE&G and only in the metropolitan areas of Columbia and Charleston because of the specialized metering equipment required.

Under this rate you are billed for consumption in kilowatt hours (kwh) as well as for the demand (kw) you place on the electric system during peak use hours.

Billing on a time of use rate may be significantly higher than the same consumption on SCE&G's regular Rate 8 unless a dedicated effort by the homeowner is instituted. For many customers it would require a significant change in life style in order to confine the great majority of electric use to SCE&G's off-peak hours. It could require significant investments in controls, larger water heater-storage units or other devices.

If you are interested in the time of use rate, please contact your local SCE&G business office for assistance in evaluating your potential for savings under this rate.

Residential Energy Conservation Rate

Please send me more information on your new REC Rate.

Name _____ Acct # (from bill) _____

Address _____

City _____ State _____ Zip _____

(please print)

ELECTRICITY RATES OF THE FUTURE ANALYZED [13]

Alternative policies that could reduce both the use of oil and natural gas by utilities and the need for new powerplants are examined in an FEA interim report sent to Congress this month.

Such policies could improve the efficiency of electricity production and ultimately lower the cost of electricity to consumers, according to the report. The costs of primary fuels, new generating plants and other utility costs, have raised average electricity prices 70 percent in the 1970-1976 period.

The 376-page interim report reviews the current state of knowledge regarding a wide range of alternative electric utility rate designs, load management practices and other policies. A final report, which will contain a more detailed analysis will be submitted in the coming months.

"Go easy with those; have you any idea what our electric bills are like nowadays?"

Four broad issues of utility policy are analyzed in the report:

- Rate reform and load management practices to flatten peak demand;
- Fuel policies to minimize utility dependence on oil and natural gas;
- Improved powerplant reliability and other measures to reduce reserve margins without unduly sacrificing system reliability;
- Utility financing procedures which maintain the economic viability of the industry and encourage management efficiency.

Seven alternative rate design proposals are examined:

- Declining block rates, with lower prices per kilowatt-hour for greater quantities of usage;
- Time-of-use rates, in which the prices vary according to whether the electricity is consumed during peak or offpeak periods;
- Flat rates, with a uniform price per kilowatt-hour for all customers and levels of usage;
- Inverted rates, in which the price per kilowatt-hour is higher for greater quantities of usage;
- Three-part rates, in which there is a charge for the peak demand registered at any time during the month and/or a customer charge, in addition to a charge for the number of kilowatt-hours used;
- "Lifeline" rates, in which residential customers with specified minimum levels of usage receive reduced rates;
- Time-of-use lifeline rates, in which rates above specified minimum usage levels are based on the future costs of providing electricity.

In addition to alternative rate designs and load management practices, the report also examines alternatives for decreasing utility use of scarce resources. The report points out that coal conversion, solar energy and the cogeneration of electricity and industrial steam hold significant potential for decreasing the nation's reliance on imported petroleum and other insecure or scarce energy supplies.

Copies of the Executive Summary of the *Interim Report: Electric Utility Rate Design Proposals* are available for public inspection at FEA headquarters and regional offices.

$280.00

BTU'S 14,000

WATTS 2,760

$400.00

BTU:S 14,000

WATTS 1.380

ENERGY EFFICIENCY[22]

Recall the fact that a lighted bulb is hot to the touch. Only 10% of electric energy used by an ordinary bulb is usuable light, the other 90% is lost in heat. Probably more than 60% of the monthly electric bill goes for wasted energy - heat. A gasoline driven verhicle requires a radiator to cool or to keep it from being melted by the wasted heat it generates.

Note: The fan on an overhead projector has to run to cool the projector due to the heat from the light.

For this reason the consumer can never get 100% efficiency out of any use of energy when it is converted or when conversions are made. The question of importance is the efficiency with which the conversions are made.

The efficiency of any conversion is the ratio of the useful work or energy that is derived from the conversion of the work or energy put into it.

In tracing the energy flow through our economic system we have, so far, treated it as if the system were perfect. It is now time to look at the leak, the looses which occur at each one of the conversions, from primary source through intermediate form (or forms) to end use.

We must make it clear from the beginning that our use of the term ''loss'' is meant to indicate that energy is lost for future useful conversion. It does not, of course, disappear; the First Law guarantees that. It is the Second Law, which imposes the ''heat tax'' on all energy conversions, that is important here.

A concept from physics that is useful to us is that of irreversibility. All natural energy conversions are irreversible, which is to say that energy converted from one form to another cannot then be completely converted back to its original form. As an example, a falling rubber ball has its original amount of gravitational potential energy converted to the kinetic energy of motion. When it strikes the ground, this kinetic energy is converted, by distortions of the molecules within the ball, to elastic potential energy. A large fraction, but not all, of this elastic potential energy is then converted back to kinetic energy when the ball rebounds. No ball (not even the ''super ball'') bounces all the way back to its original height. We could gain a strong clue as to where this ''lost'' energy resided if we could take the temperature of the ball before and after its bounce. We would find it warmer afterward: some of the original mechanical energy is converted to heat energy; the ''heat tax'' is collected.

This ''heat tax'', of course, is collected in all the energy conversions we showed previously. In conversions to and from mechanical energy, some of the heat tax is paid through the dissipative force, friction. In thermal conversions, some of the heat leaks out of the system. In electrical conversions, some of it is changed to heat by the electrical resistance and leaks away. The heat tax is also paid in energy storage conversions.

When water is pumped uphill, for instance, some of the initial energy is lost again to friction in the pump, in the water, and between the water and the pipe.

In all the conversions we have been considering, therefore, there are "losses"; energy is diverted from its intended use. A measure of the importance of these losses is the efficiency of an energy conversion device.

An efficient person is one who seems to get a lot of work done with a minimal expenditure of effort. The physical definition of efficiency is smiliar: the efficiency of any energy conversion is the ratio of the useful work or energy that is derived from the conversion to the work or energy put into it. In symbols, the efficiency E is

$$E = \frac{\text{Work or Energy Out}}{\text{Work or Energy In}} \times 100$$

(The multiplication by 100 allows us to express the efficiency as a percent.)

As an example, if we burn a gallon of gasoline in an automobile engine set on a test block and measure the mechanical work output, we find that is amounts to 8,200 calories. The chemical potential energy of the gallon of gasoline is 32,830 Calories. The efficiency of the engine therefore is

$$E = \frac{8{,}200 \text{ Calories} \times 100}{32{,}830 \text{ Calories}} = 25 \text{ percent}$$

The efficiencies of other energy conversions are defined in like manner. Although it is theoretically possible to convert all of a given amount of chemical potential energy to heat by combustion, furnaces are not 100 percent efficient, some of the fuel is not completely burned and some of the heat energy is lost through the furnace walls. The efficiency of a conversion to heat energy is, therefore,

$$E = \frac{\text{Heat Delivered}}{\text{Chemical Energy Input}} \times 100$$

•Appliance Labeling

Facts You Should Know About Appliance Labeling

When you shop for a major appliance, look for the new yellow and black **EnergyGuide** labels that will help you save money.

An **EnergyGuide** label shows the yearly energy cost of operating an appliance and allows you to compare it to the energy cost of competing brands and models of a similar size with similar features. When considered along with the purchase price, you'll be able to determine which appliance is less expensive to own and operate over the long run.

Appliances Covered

EnergyGuide labels are required on the following major appliances manufactured on or after May 19, 1980:

- Furnaces
- Refrigerators and refrigerator freezers
- Freezers
- Water heaters
- Clothes washers
- Dishwashers
- Room air conditioners

Central air conditioners and heat pumps will be labeled at a later date.

EnergyGuide labels will not be used for kitchen ranges or ovens, microwave ovens, television sets, clothes dryers, humidifiers and dehumidifiers, or home heating equipment other than furnaces. These appliances have less difference in operating costs between brands and models.

Labels also will not be required on small appliances, such as toasters, blenders, and coffee makers, because they require relatively little energy to operate.

The seven types of major appliances that are being labeled account for 73 percent of all energy consumed in American homes.

Federal Law

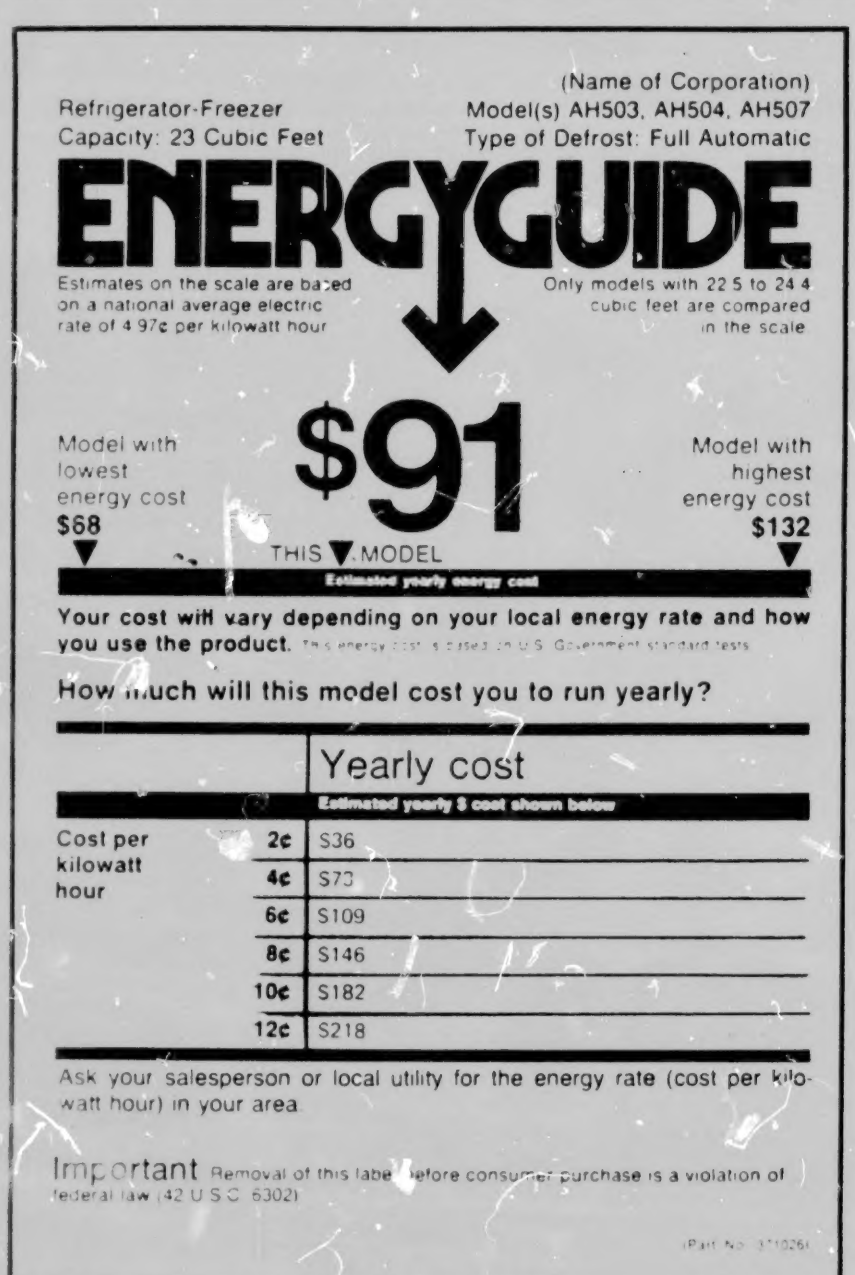
Appliance labeling was mandated by Congress as part of the Energy Policy and Conservation Act of 1975. The U.S. Department of Energy and Federal Trade Commission jointly manage its implementation.

U.S. DEPARTMENT OF ENERGY

Assistant Secretary for Conservation and Solar Energy
Division of Buildings and Community Systems

Copies of this Fact Sheet may be obtained from:

U.S. Department of Energy
Technical Information Center
P.O. Box 62
Oak Ridge, TN 37830



(Name of Corporation)
Refrigerator-Freezer
Model(s) AH503, AH504, AH507
Capacity: 23 Cubic Feet
Type of Defrost: Full Automatic

ENERGYGUIDE

Estimates on the scale are based on a national average electric rate of 4.97¢ per kilowatt hour

Only models with 22.5 to 24.4 cubic feet are compared in the scale

Model with lowest energy cost $68

$91

THIS MODEL

Model with highest energy cost $132

Estimated yearly energy cost

Your cost will vary depending on your local energy rate and how you use the product. This energy cost is based on U.S. Government standard tests

How much will this model cost you to run yearly?

	Yearly cost
	Estimated yearly $ cost shown below
Cost per kilowatt hour 2¢	$36
4¢	$73
6¢	$109
8¢	$146
10¢	$182
12¢	$218

Ask your salesperson or local utility for the energy rate (cost per kilowatt hour) in your area

Important Removal of this label before consumer purchase is a violation of federal law (42 U.S.C. 6302)

(Part No. 3710261)

A Sample Energy Cost Label

Energy-Efficient Appliances

You may find that energy-saving appliances cost slightly more to buy because intermittent ignition devices, better motors and compressors, more or better insulation, or other special features make manufacturing somewhat more expensive. Over the lifetime of an appliance, however, the lower operating cost of many energy-efficient products more than offsets the higher purchase price and helps to pay back the initial expenditure.

To shop for the best buy on major appliances, you need to become familiar with three types of **EnergyGuide** labels: Energy Cost, Energy Efficiency Rating, and Generic.

Energy Cost Labels

Energy cost labels are used on refrigerators and refrigerator-freezers, freezers, water heaters, dishwashers, and clothes washers.

The large number in the center of the label is the estimated annual cost ($91) of the energy required to operate the appliance, based on a national average electricity rate of 4.97 cents per kilowatt-hour. The bar beneath it shows the range of operating costs of competing brands and models of similar size and features. Therefore, you will quickly be able to see how the model you are considering compares to others.

At the bottom of the label is a chart that allows you to determine more precisely what your cost to operate that appliance will be, based on your local utility rate.

Energy cost labels for dishwashers and clothes washers also include a chart that indicates the cost of running the appliance with either a gas water heater or an electric water heater. Your salesperson or utility company representative can tell you the energy rate for your area, or sometimes that information is included in your utility bill.

Energy Efficiency Rating Labels

Climate control appliances, such as room air conditioners, are labeled with an *Energy Efficiency Rating* (EER) or a *Seasonal Energy Efficiency Rating* (SEER). The rating is printed in large numbers in the center of the label. A *higher* number indicates a more efficient appliance.

There also is a range—printed just below the energy efficiency rating—for competing room air conditioners of the same cooling capacity so that you can make shopping comparisons easily. In addition to the energy efficiency rating, the label provides a cost/use chart so that you can calculate the energy cost of the appliance based on local electricity rates and expected hours of use.

Room Air Conditioner
Capacity: 9500 BTU/hr

(Name of Corporation)
Model(s) XXXXXXX

ENERGYGUIDE

Models with the most efficient energy rating number use less energy and cost less to operate.

Models with 9300 to 9799 BTU's cool about the same space.

Least efficient model 5.7

6.1

Most efficient model 10.2

▼ THIS MODEL

Energy Efficiency Rating (EER)

This energy rating is based on U.S. Government standard tests.

How much will this model cost you to run yearly?

Yearly hours of use		250	750	1000	2000	3000
		Estimated yearly $ cost shown below				
Cost per kilowatt hour	2¢	$8	$23	$31	$62	$94
	4¢	$16	$47	$62	$125	$187
	6¢	$23	$70	$94	$187	$281
	8¢	$31	$94	$125	$250	$374
	10¢	$39	$117	$156	$312	$468
	12¢	$47	$140	$187	$374	$562

Ask your salesperson or local utility for the energy rate (cost per kilowatt hour) in your area. Your cost will vary depending on your local energy rate and how you use the product.

Important Removal of this label before consumer purchase is a violation of federal law (42 U.S.C. 6302).

GPO 863 901 (Part No. 20648)

A Sample Energy Efficiency Rating Label

(for central air conditioners
and furnaces)

ENERGYGUIDE

You can save substantially on home heating and cooling energy costs by following the simple steps outlined below:

1. Weatherproof your house
2. Assure energy efficient heating and cooling equipment selection and installation
3. Operate and maintain your system to conserve energy

Help conserve energy. Compare the energy efficiency rating and cost information for this model with others. Check the figures and spend less on energy. Your contractor has the energy fact sheets. Ask for them.

Important

Removal of this label before consumer purchase is a violation of federal law (42 U S C 6302)

A Sample Generic Label

Generic Labels

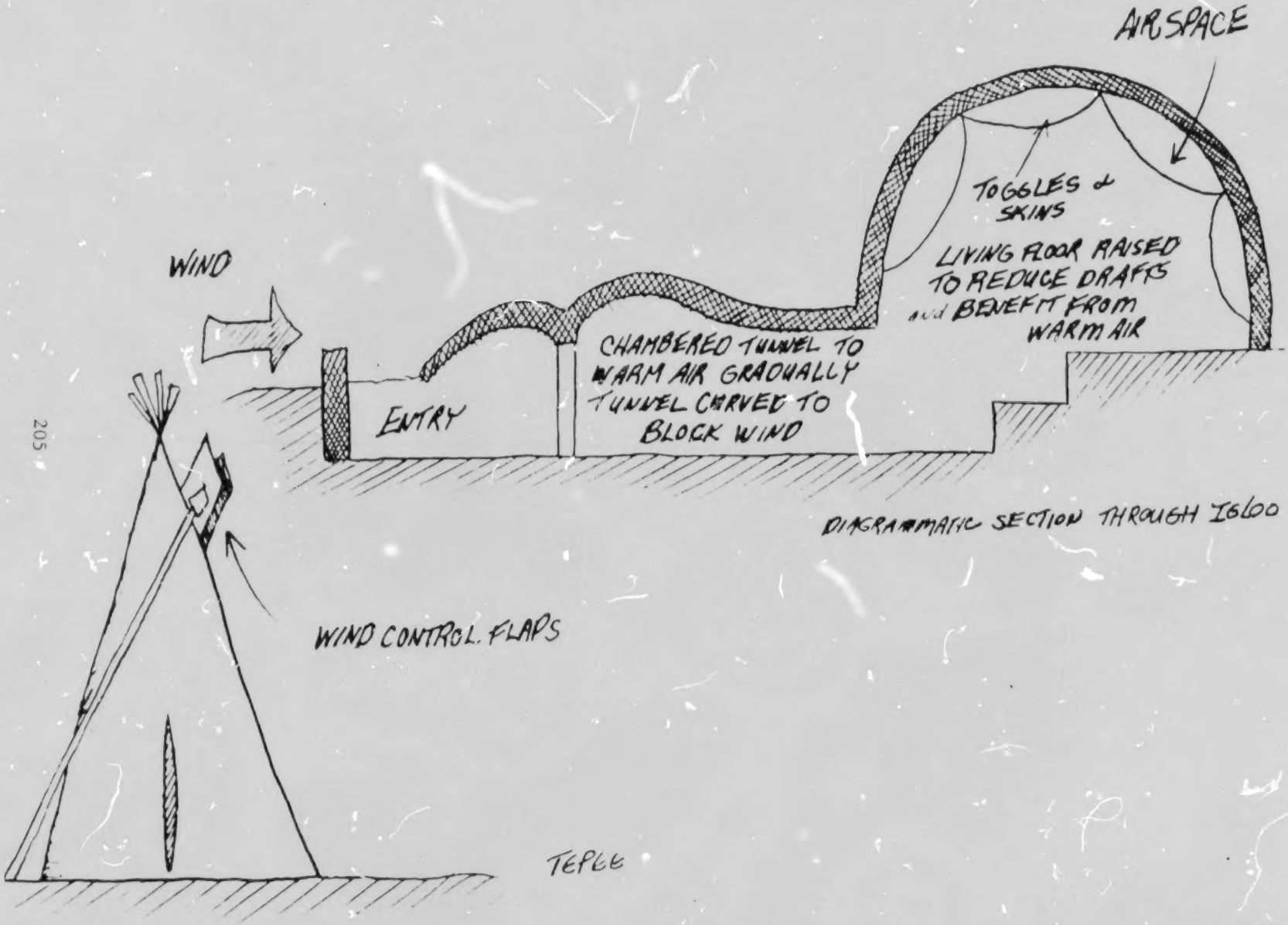
The Generic label required on all furnaces contains general information on how to conserve energy in the home. It also directs you to an energy fact sheet developed by the manufacturers, which your dealer or heating system contractor will have for each product. The fact sheet contains information on system components and overall efficiency on different combinations, and gives energy costs of the system for various geographic locations and utility rates. Similar generic labels will be required for central air conditioning systems as soon as standards are final.

Use Appliances Wisely

In addition to buying the most energy-efficient appliances suited to your particular needs, you can save even more money and natural resources by the careful use of those appliances in your home. Consider combining loads in dishwashers and clothes washers, using low temperature settings where possible, avoiding unnecessary opening of refrigerator doors and other simple energy conservation methods. If we could cut residential energy use by only 20 percent, the reduction would amount to more than half a billion barrels of oil per year—or about one-sixth of our nation's oil imports.

FARM IN NORMANDY

HOUSES LOCATED FOR MAXIMUM PROTECTION AGAINST COLD WINDS IN SWITZERLAND


AIR SPACE
TOGGLES & SKINS
LIVING FLOOR RAISED TO REDUCE DRAFTS and BENEFIT FROM WARM AIR
WIND
CHAMBERED TUNNEL TO WARM AIR GRADUALLY TUNNEL CURVED TO BLOCK WIND
ENTRY
DIAGRAMMATIC SECTION THROUGH IGLOO
WIND CONTROL FLAPS
TEPEE

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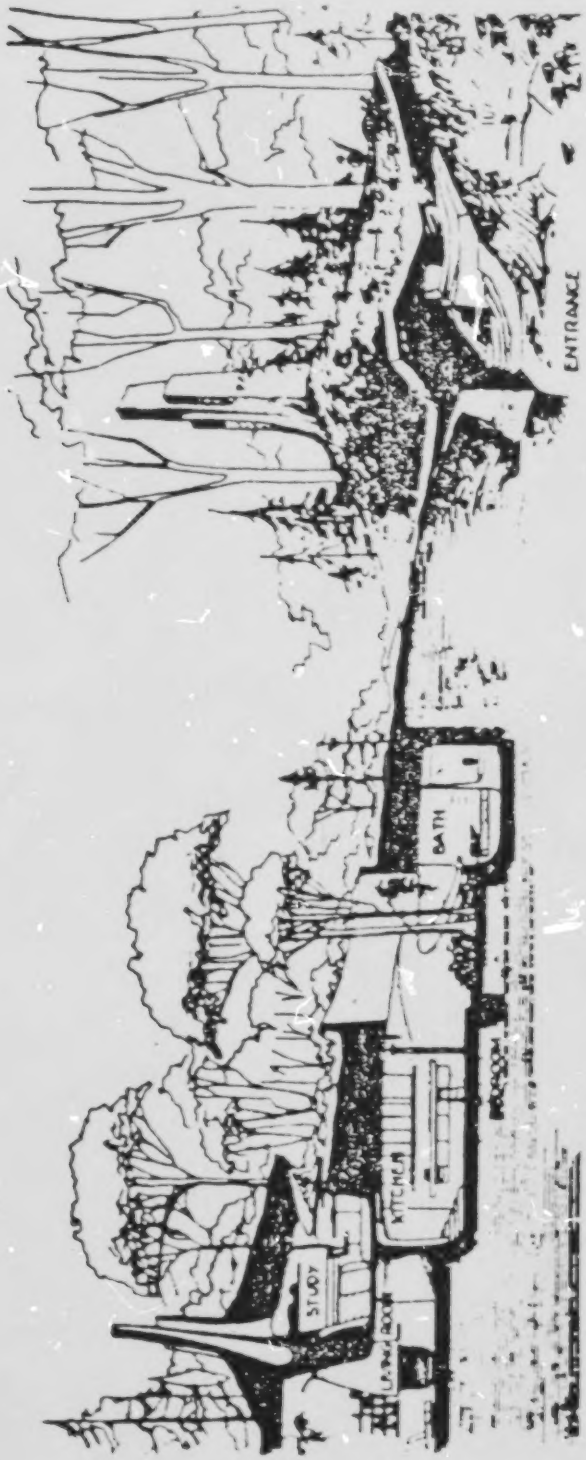
UNDERGROUND HOUSE



INTRODUCTION

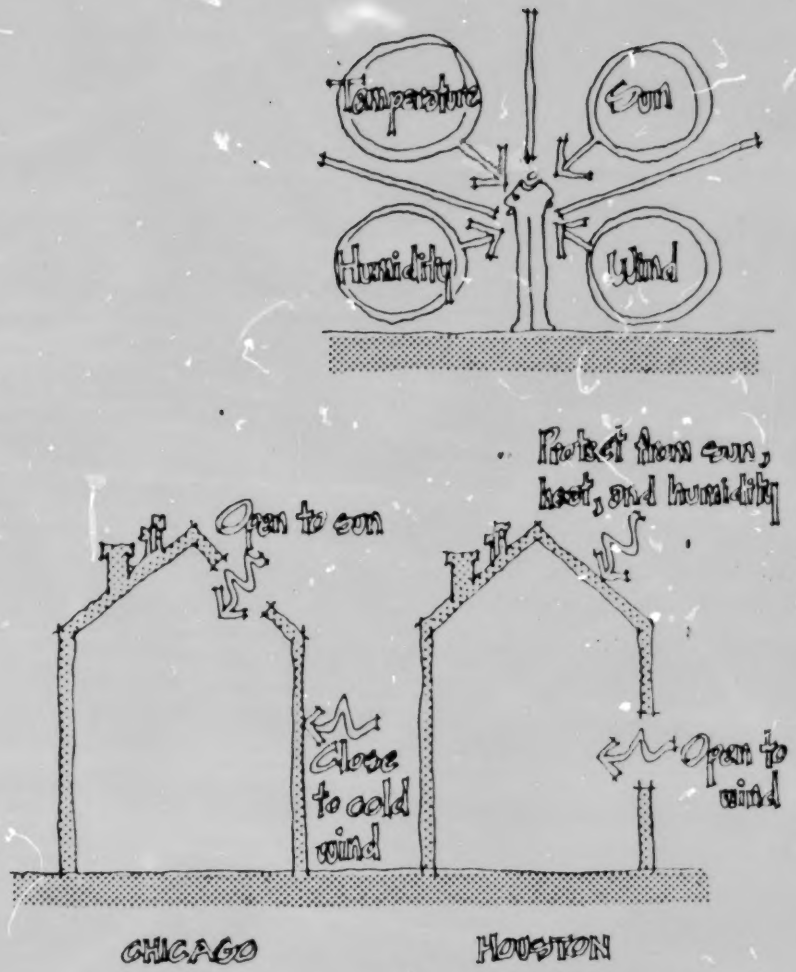
Climate, Comfort and Your Building

28

REGIONAL GUIDELINES FOR BUILDING PASSIVE ENERGY CONSERVING HOMES

A building separates inside spaces from the outside environment with the primary purpose of creating comfortable conditions for the occupant. Mechanical systems are designed to provide heating and cooling whenever outside conditions make the inside spaces uncomfortable. One of the most effective ways to save energy in residential buildings is to build responsively to the outside climate and thereby reduce dependence on mechanical systems. *Energy conservation* involves building to isolate the interior of a home from an 'alien' climate, and *passive design* involves opening the same interior to a 'friendly' climate for natural conditioning.

To be more specific, *temperature, humidity levels, wind speeds, and sunshine* define the climatic environment in which a building must operate. In building design, construction and use, protection from some of these climatic forces as well as advantageous use of other of these forces significantly reduces the energy demand for mechanical systems. In other words, depending on where you are, different climate conditions can be a *liability or an asset* to your home energy consumption.



When your climate is too cold for comfort, you instinctively reduce your heat loss by insulating yourself with layers of sweaters and coats. While waiting for a bus you might back yourself against a building or behind a barrier for protection from the cold winds, and you'd put on a protective hat to keep the freezing rains from carrying heat away from your head. These are your personal methods of *energy conservation*, shielding yourself from the liabilities of climate. On sunny winter days, however you might find yourself skiing in shirt sleeves because of the *passive heating* potential of the sun.

When your climate is too hot for comfort, you instinctively seek the coolest spot available, well shaded from the hot sun, to shield yourself from the liabilities of this climate, practicing personal *energy conservation*. At the same time, you might put on the lightest clothing you can find or go into a sunken room or cellar for a cool refuge. You are naturally responding to the *passive cooling* potential, or assets, of natural ventilation or of underground construction.

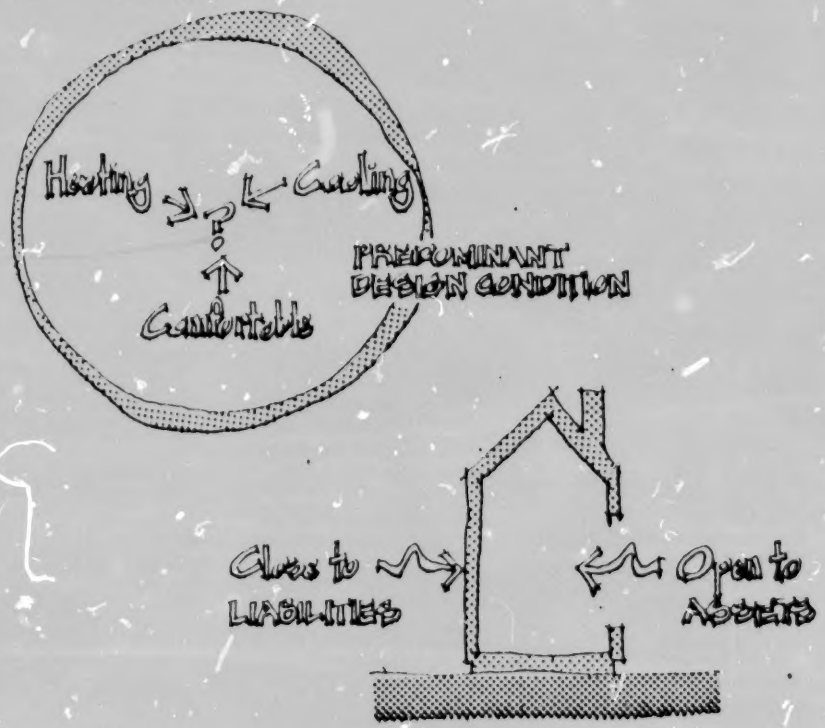
Building an energy conserving and passively conditioned house is no different than your personal responses to the liabilities and assets of climate.

A house in Chicago is faced with two major problems or liabilities—cold temperatures and high wind speeds. This house should be able to close down to these conditions, which increase heating loads, with insulation, weatherstripping, and airlock entries. The house should also be built to respond to the warmth of sunshine which decreases heating loads. The same house built in Houston should be able to shut down to the liabilities of hot temperatures, sunshine, and high humidities, which increase cooling loads, and to open up to the blessings of wind for natural conditioning. In other words, the basis for effective energy conscious design is responding to the *liabilities and assets* in your climate which determine the mechanical system's loads and resulting energy use.

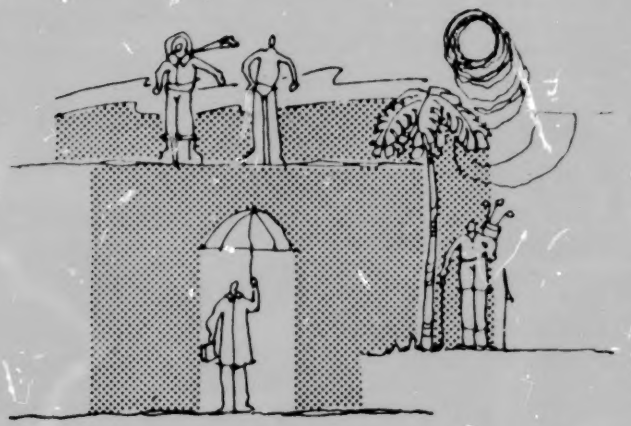
How to Define Your Climate:[28]

The climate in which you build is made up of four factors: *temperature, humidity, wind, and sun.* Energy conscious design is dependent on the regional variations in these factors. Three definitions may be helpful in defining your climate:

Basic climate condition
Climatic liabilities
Climatic assets



BASIC CLIMATE CONDITION is the season, or climatic condition, to which your building is most often exposed.
Are you predominantly heating?
Are you predominantly cooling?
Are you predominantly comfortable?,



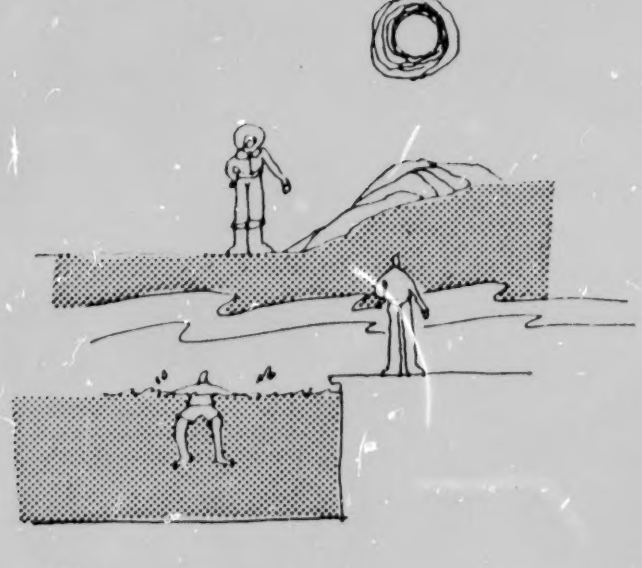
CLIMATIC LIABILITIES are those factors (of sun, wind, temperature, humidity) which make your seasonal conditions worse. Isolating yourself from these climatic liabilities is the basis of energy conservation, reducing the heating and cooling demand on the house.

Temperatures can be a liability in both hot and cold climates especially if it is consistently too hot or consistently too cold.

Wind is a liability in cold climates because it carries away heat quicker than usual. Wind can also be a liability to comfort in hot dry climates when winds cause the human to dehydrate and consequently overheat.

Moisture can be a liability if it comes in the form of humidity, causing such stickiness that one cannot evaporatively cool (cooling by sweating) in summer.

Sun is rarely a liability in cold climates but can be a significant problem in hot climates.



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CLIMATIC ASSETS are those forces (of sun, wind, temperature, moisture) which make the seasonal conditions more comfortable. Opening up to the assets of climate is the basis of passive design and offers methods of replacing the fuel supply with non-depletable resources.

Diurnal temperature conditions are day-to-night temperature shifts (from daytime heating to nighttime cooling) which exist in very dry areas and at high elevations. A day-to-night temperature swing can be flattened by the use of heavy construction, to yield constant temperatures throughout the day.

Wind can be an asset in hot, humid climates to provide natural ventilation, allowing air conditioners to be shut off.

Sun can be an asset in cool and cold climates to provide passive heating, allowing heaters to shut off, or heating loads to be reduced.

Even *moisture* can be an asset by evaporating in hot, dry climates to cool and humidify the air—a natural air conditioning system.

All of these assets can be accommodated with simple design changes such as siting, orientation, wall construction, and window placement, as seen in the following chapters. They can also become sophisticated heating and cooling systems for the passive home, requiring the understanding of some basic technologies which are outlined in Part II of this publication.

With these definitions of basic climate conditions, climatic liabilities, and climatic assets, you can begin to define your climate for energy conscious design in a country of numerous climates.

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9

Supplement 37 con't.

What is Your Basic Climate Condition?

What kind of comfort conditioning, if any, do you rely upon most often? You may know immediately, but filling out this table will give you real percentages and also indicate the severity of the climate. Do you really need to heat and cool all these months or could careful design allow for 'natural' conditioning?

CHECK A BOX FOR EACH MONTH

	COLD	COOL	COMFORT	WARM	HOT
JAN					
FEB					
MAR					
APR					
MAY					
JUNE					
JULY					
AUG					
SEPT					
OCT					
NOV					
DEC					

COLD? Often below freezing. When severe winters persist for long periods of time, the best way to combat wasteful energy consumption is to isolate the building from adverse climate conditions.

COOL? 40's, 50's, and 60's. Although mechanical heating is still required, mild winter climates offer the builder and occupant immediate potential for passive solar heating.

COMFORTABLE? Comfortable conditions in all seasons imply a need for openness to quickly equalize the pleasant conditions outside the building with the sheltered conditions inside the building.

WARM? In the 80's. When summer temperature conditions are not severe and cooling needs can be met by natural techniques, interaction with the environment is the most energy conserving approach to cooling your home.

HOT? Often above 90°F. In regions where high temperatures and high humidities combine to make for long periods of discomfort, mechanical air conditioning is required and isolating the house from the outside heat is the best way to combat wasteful energy consumption.

ADD THE CHECKS

MULTIPLY BY 8.33% FOR % OF YEAR

HOW SEVERE ARE YOUR COOLING OR HEATING NEEDS?

% HEATING	% COMFORT	% COOLING

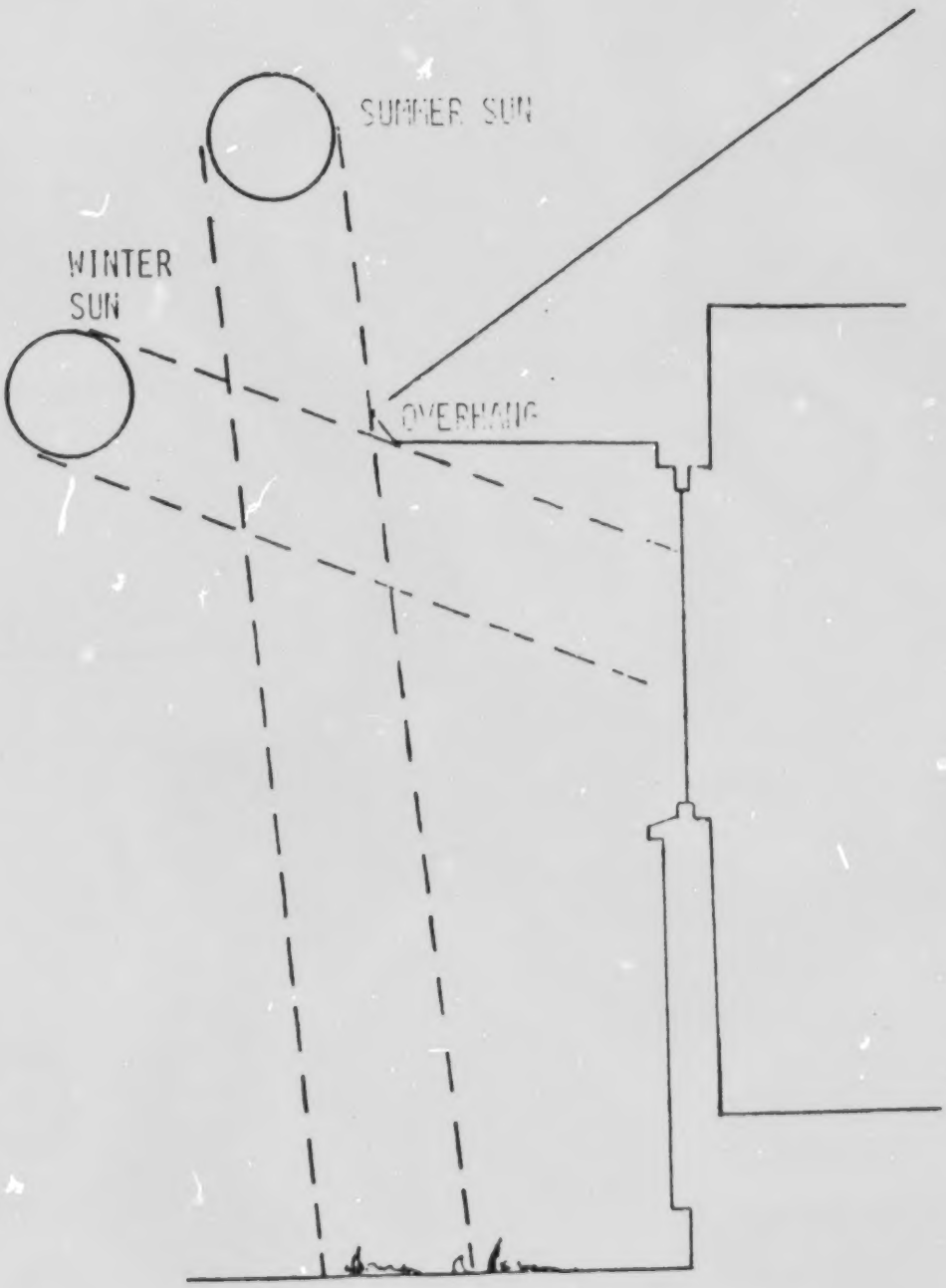
DO HEATING NEEDS DOMINATE IN YOUR REGION? Six months or more in cool or cold conditions. In areas where heating needs predominate, guidelines to minimize heat loss are your primary design concerns.

DO COOLING NEEDS DOMINATE IN YOUR REGION? Six months or more in hot or warm conditions. In areas where cooling needs predominate, guidelines to minimize heat gains are your primary design concerns.

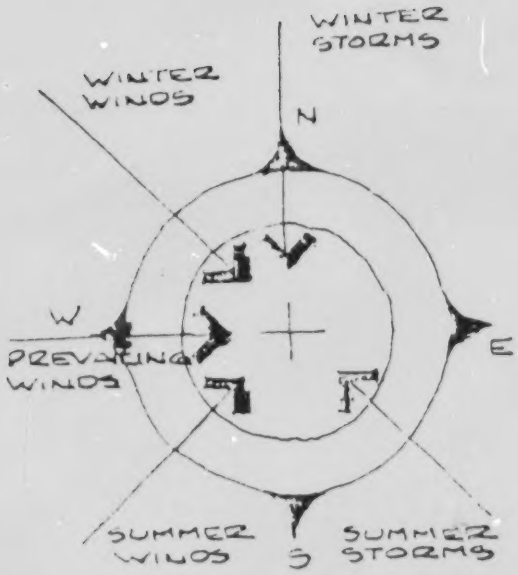
DO YOU HAVE A CHANGEABLE CLIMATE? Predominantly hot, severe summers coupled with comfortable winters, springs or falls, or predominantly cold, severe winters coupled with mild summers offer enough naturally comfortable days to require a flexible house design.

Supplement 37 con't.

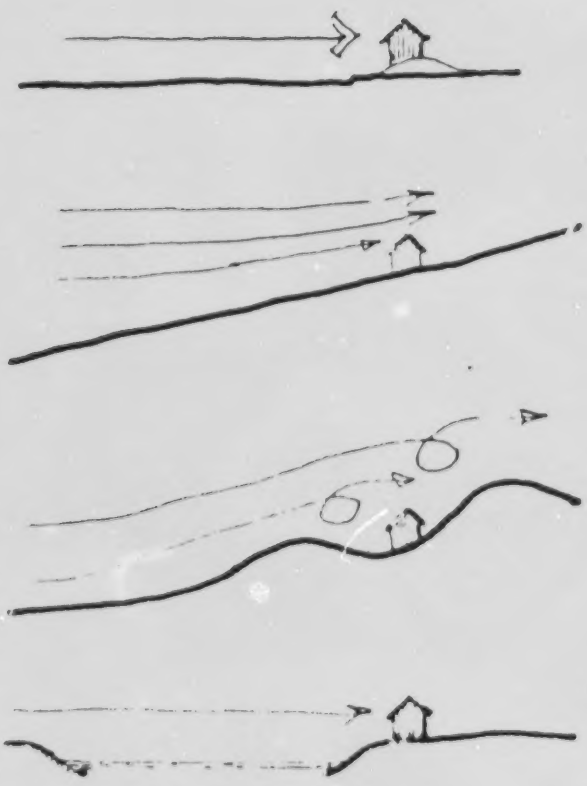
SHADING WINDOW AREAS[1]



THE WIND[1]



THE WIND



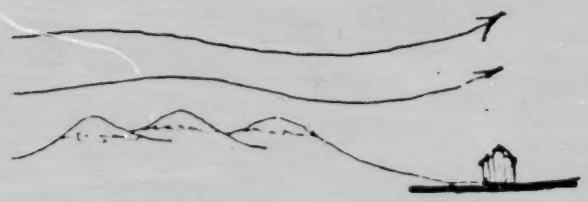
ED. NOTE:

Wind factors are generally fixed for any region or geographic areas and can be taken into account in housing selection through information acquired from weather bureaus and local residents.

Maximum consideration of wind factors in housing includes a knowledge of the west to east prevailing wind patterns and seasonal and regional variations.

GEOGRAPHIC FEATURES AFFECT WIND PATTERN[1]

CONSIDER GEOGRAPHIC FEATURES

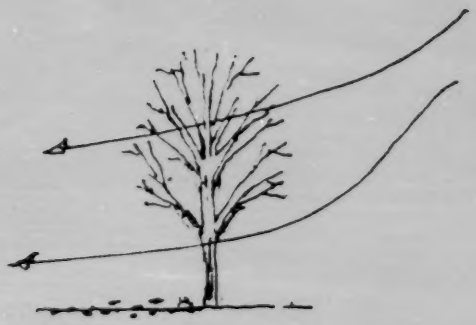


ED. NOTE: Large geographic features will affect winds. This affects warmth of home.

SLOPES AND HILLS[1]

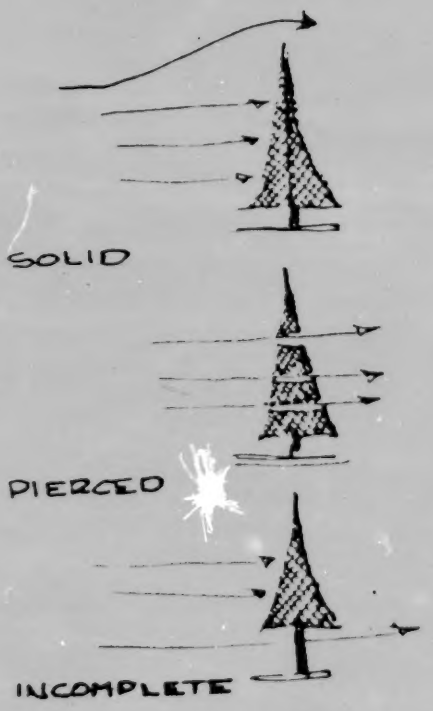
LARGE PLANTINGS - DECIDUOUS[1]

LARGE
PLANTINGS
- DECIDOUS



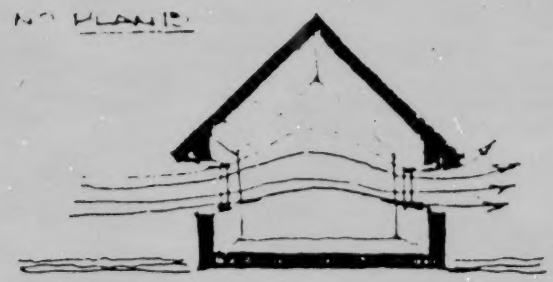
Deciduous trees are good for shading in the summer. They shed their leaves in the winter and allow the sun to reach the home. They also help redirect the wind.

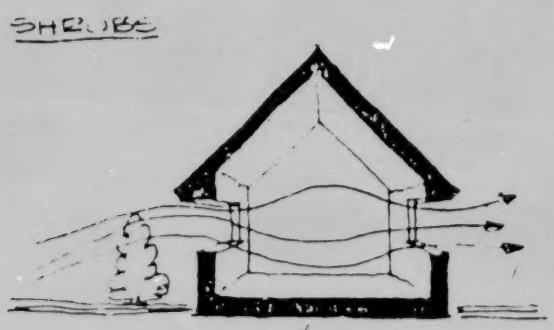
LARGE[1] PLANTINGS - EVERGREENS



Evergreens are always green. They can serve as windbreaks. Trees can give wind protection at a large scale. Shelter belts are large masses of trees planted to reduce wind velocity for a large area as a whole homestead.

NATURAL[1] VENTILATION WITH PLANTINGS



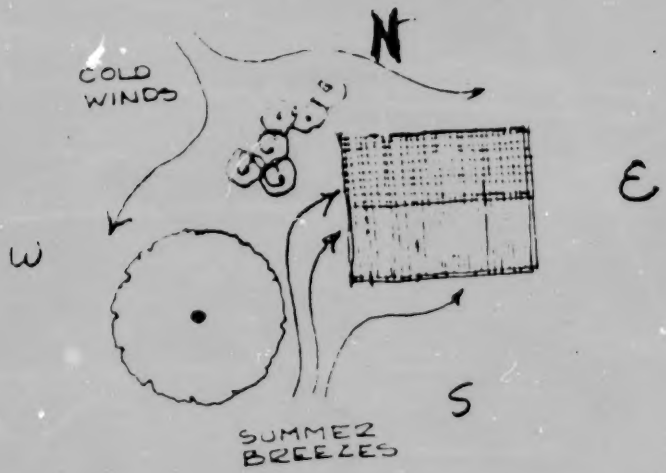


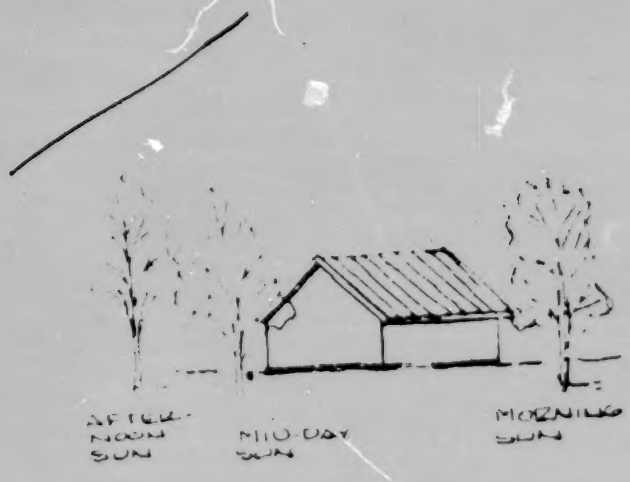
Hedges can make major changes in direction of air flow. You can redirect the breeze on the site and create dead air space. This is the way we see trees, as around the base of houses. Vines on houses can help cool in the summer.

TEMPERING[1]

A lot of pavement around the house absorbs the sun's heat since it is black colored. This can be "softened" somewhat with the use of trees.

SHADING[1]





NOTE: Trees are mainly on the north and west sides in this picture.

DESIGN/VOLUME[1]

We will read here that two factors which help determine the optimum shape of a home are:

1. Volume to surface ratio
2. Potential for insulation

SHAPE:

Some experts feel the optimum shape for thermal impact for every climate is a rectangel with differing degrees of elongation along the east-west direction. Others would claim that a cube is the optimum shape if applying the rule that the greater the enclosed volume of a building in relation to the amount of exposed surface area, the less will be the heat loss in cold climates or heat gain in hot climates.

A circular form is good for conserving heat. Long rectangular or linear shapes are best for offering maximum surface to the winds for cooling.

The volume effect (as the volume of a cube increases, its volume-to-surface area ratio increases) plays a more important role in large buildings such as apartment houses or condominiums. The climate affects large buildings because of the volume-to-surface area ratio.

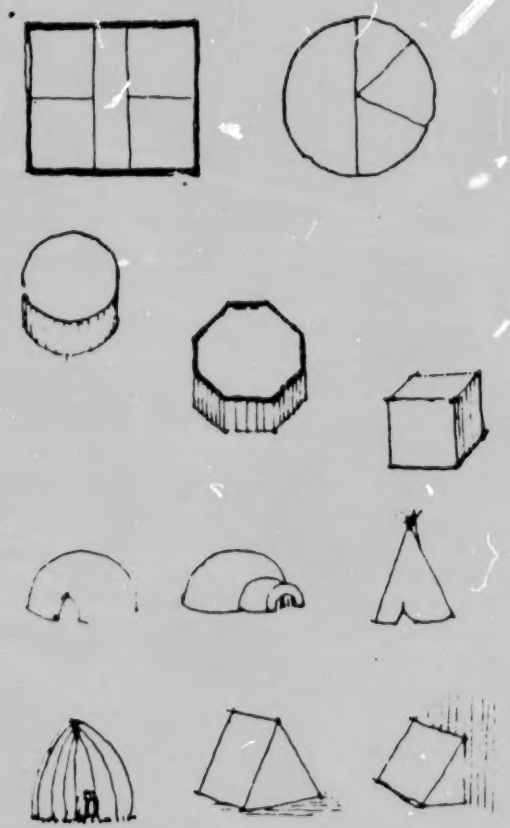
An interior apartment may have a lower heating and cooling load because it has less surface area exposed to the weather.

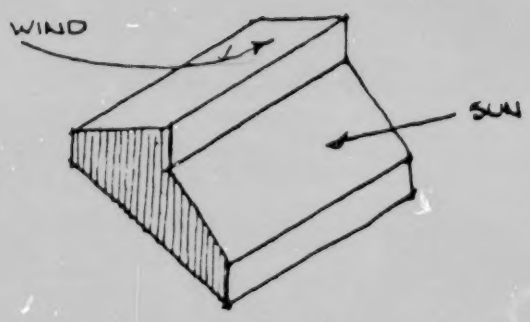
POTENTIAL FOR INSULATION:

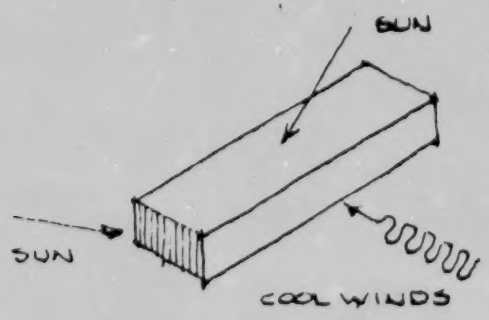
The National Association of Home Builders (NAHB) has shown that the potential for insulation is a very important factor in determining the optimum shape for thermal efficiency.

For example, the NAHB has disproved the impression that a two-story house affords less heat loss and gain than a one-story house of the same square footage. In this case, the ceiling area makes the difference since ceilings can be more effectively insulated than walls. If six-inch wall studs were used and if the insulation had an "R-value" equal to that of the ceiling, the one- and two-story houses, all other factors being equal, would have equal heat gain and loss.

DESIGN / VOLUME[1]







Long rectangular shapes offer maximum surface to the winds for cooling.

RULE:

The greater the enclosed volume in relation to the amount of exposed surface area, the less will be the heat loss in cold climates or heat gain in hot climates.

Cube - Good
Multiple story - Good

Roofings[26]

The roof and ceiling structures provide excellent opportunities for insulation and shading. The greatest heat loss in uninsulated homes is through the ceiling. (This is to be expected since heat rises.) Usually there is ample room above ceilings in the unheated attic space to accommodate several inches of insulation. The average requirement for ceiling insulation is R-19 which amounts to about six inches of glass fiber or mineral wool insulation. However, to be a "Super Saver" the ceiling may need an "R-Value" as high as 30. If the ceiling construction does not permit several inches of insulation, such as concrete ceilings and mobile home ceilings, rigid foam board insulation can be applied either above or below the existing ceiling. (See Figure 19.) It should be noted that attics require ventilation in both winter and summer; in winter, the vents let moisture vapor escape; in summer, the open vents carry warm air out. (See Figure 20.)

The most commonly used shading device in home construction is the overhang. Through the use of properly designed overhangs, the home can be protected from the sun in overheated periods and exposed in underheated periods. Since the use of overhangs is determined by climate and orientation, it varies from one area to another. Generally, it is desirable to protect the home from summer sun and permit the winter sun to warm the home, as shown in Figure 21.

Another important aspect is roof color. ASHRAE and HUD studies have shown that light-colored roofing material is best, but that the degree of effect on interior heating and cooling load is greatly influenced by the amount of ceiling or roof insulation. In the HUD test of single family residences the change from a white roof to a black roof only slightly reduced the heating load while increasing the cooling load substantially.

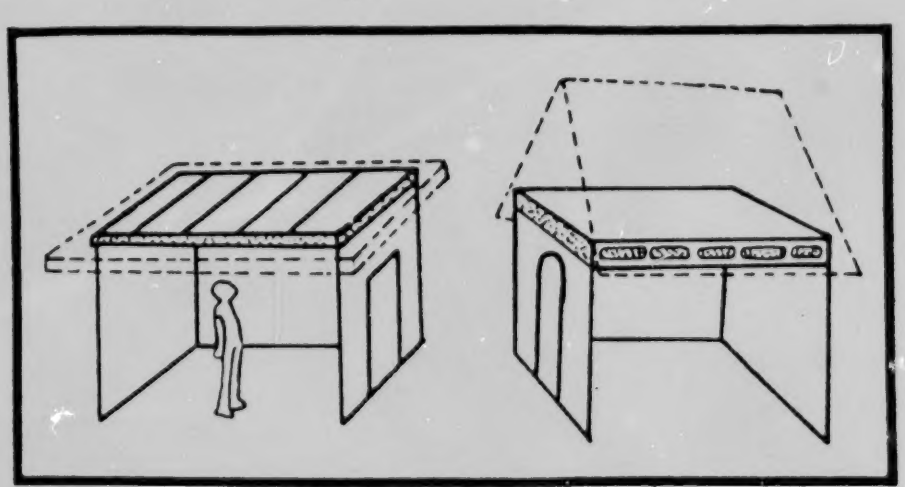


Figure 19. Ceiling Insulation Applications.

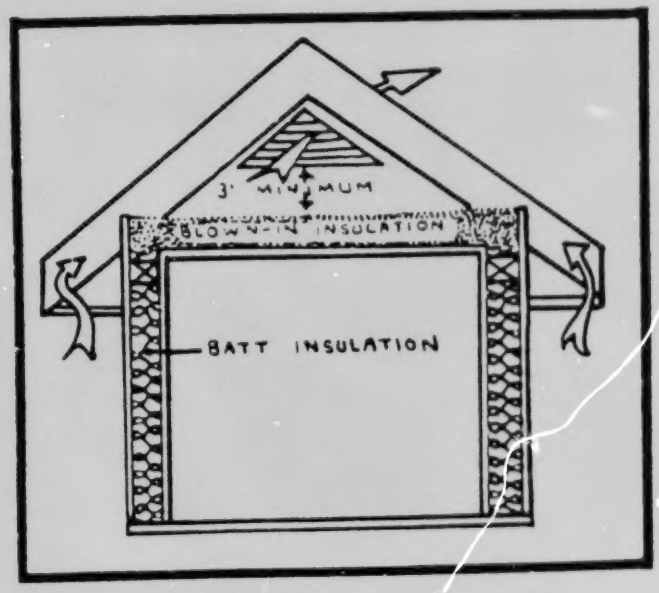


Figure 20. Combining Attic Ventilation with Two Types of Insulation.

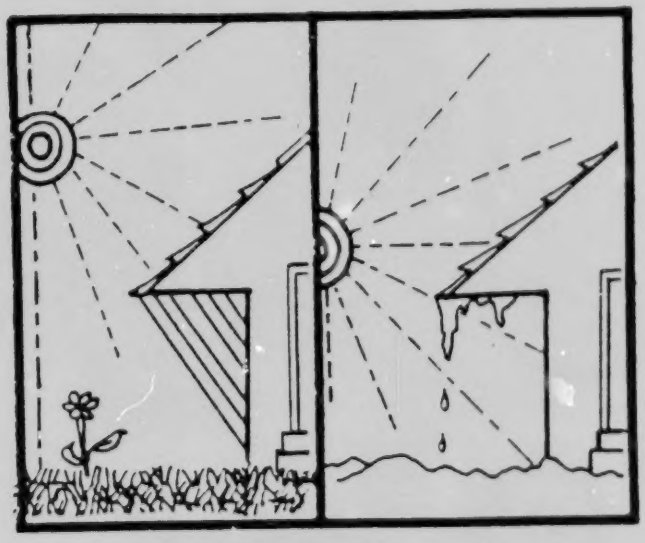


Figure 21. Summer and Winter Sun.

ROOF PITCHES [1]

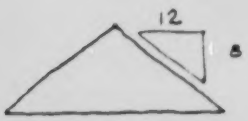
FLAT

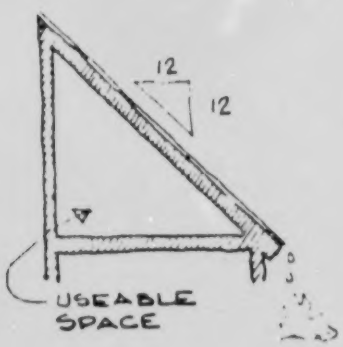
Holds snow for insulation.

PITCHED

Sheds water.

LOW PITCH





STEEP PITCH

Roofs may be categorized as flat or pitched. Pitched roofs can be termed as a low or steep pitch. Flat roofs hold snow for insulation. Steep pitched roofs are good for placing solar collectors.

FOUNDATIONS

Foundations common in the United States may fall into one of three types shown on the transparency, Supplement 54B.

1. Isolated piers in which parts of the floor area are open to the wind.

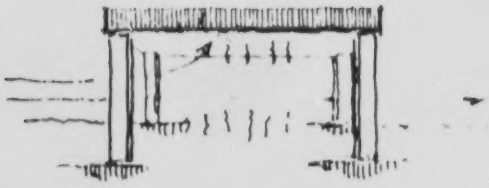
2. Continuous footing and foundation walls. (A home with a basement is this type.)

3. Slab on grade which is more suited to warmer climates. Note that the footings need to be below the frost line.

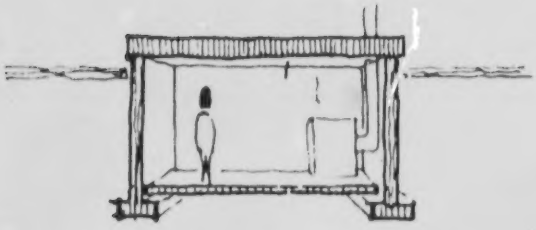
An uninsulated foundation is a good design for hotter climates because it allows heat to flow into the ground below, thus providing free cooling. Mansory foundation walls have very poor thermal resistance qualities so they should not be overlooked.

No one type of foundation has better thermal properties than another if each is properly insulated; however, crawl space foundation provides ventilation and separation from ground moisture in warm climates.

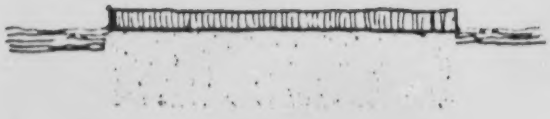
FOUNDATIONS[1]



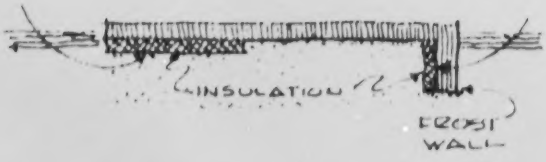
Isolated Piers



Continuous foots and foundation walls (Home with basement)



Slab on grade. No insolation. Good in hot climates.



Insulation needed here for cold climates.

Windows and Doors

Openings in a home (such as windows and doors) allow heat to escape in winter and enter in summer, creating a load on the heating or cooling system. Eight times as much heat will pass through one square foot of window area as will pass through one square foot of wall area. This assumes that the wall is insulated and the window has a storm window.[19] Even a two-inch solid door with a wood storm door has a heat loss 3.5 times greater than a typical wall.[20]

A government report on single-family residences indicates that 15 percent of the home's heating load and 4.5 percent of the cooling load was attributed to the windows and doors, with the windows contributing 13.6 percent of the heating load. Heat loss and gain through windows and doors can be reduced by storm panels, weatherstripping, double-glazing, vestibules, shading devices, and wise placement. It is estimated that a 20 percent reduction in heating bills could be realized by adding storm doors and windows. They are also effective in warm weather where they do not prevent the utilization of natural ventilation.

A storm door or window is actually an additional door or window with an air space between it and the existing door or window (see Figure 25). Storm windows will cut in half the heat that passes through windows in your house. In addition, they cut in half the difference between room temperature and window temperature. This prevents the drafty feeling around windows and reduces condensation.[21] (See Figure 26.)

Similar reductions can be achieved with double-glazed windows or plastic applied to windows. Double-glazed windows have two panes of glass factory-sealed together with a small air space between them (see Figure 27). Double-glazing has about twice the R-value of single glazing. The increase in R-value is due primarily to the air or vacuum between the two layers of glass.[22] Heat transfer can be further reduced by triple-glazing (Figure 28). However, this is cost-effective only in the most severe climates. Clear plastic over windows can accomplish much the same purpose as storm windows or glazing for very little cost. The plastic is taped, stapled, or tacked on the inside or outside of windows but usually lasts only one year.

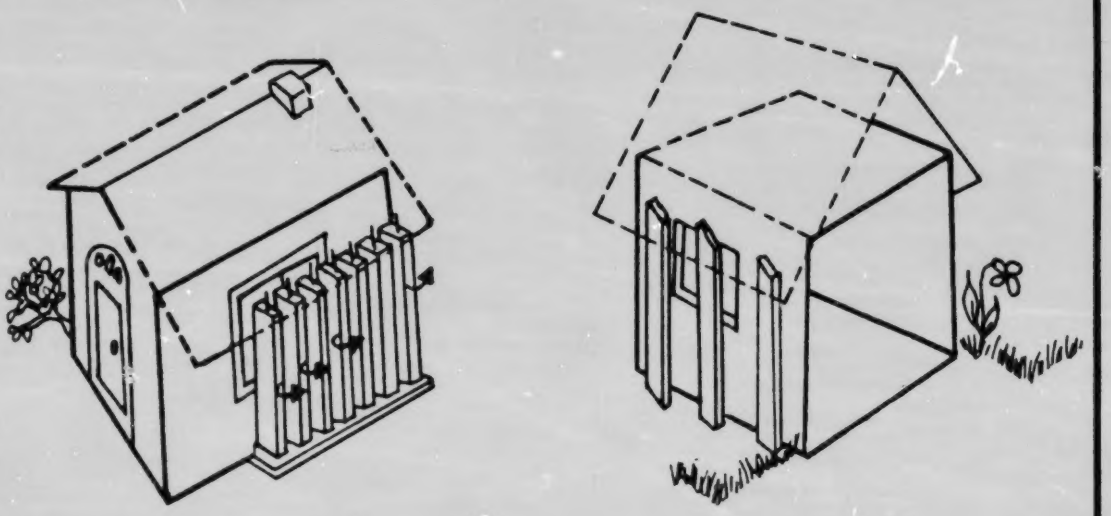


Figure 24. Exterior Sun Shades: Louvres *(left)* and Baffles *(right)*.

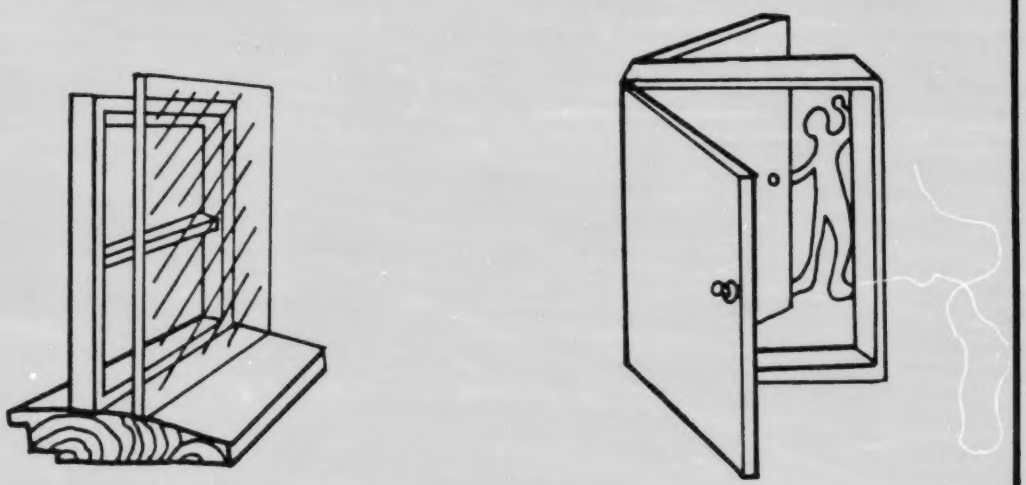


Figure 25. Storm Window Panel *(left)* and Storm Door *(right)*.

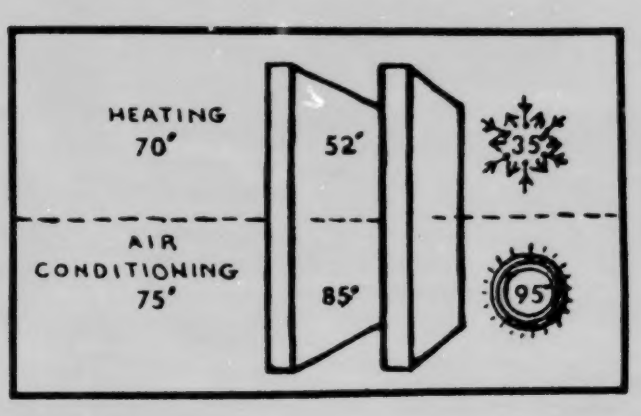


Figure 26. Storm Window Effect on Temperature.

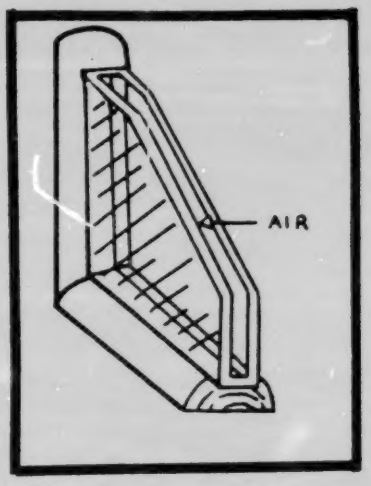


Figure 27. Double-Glazed Window.

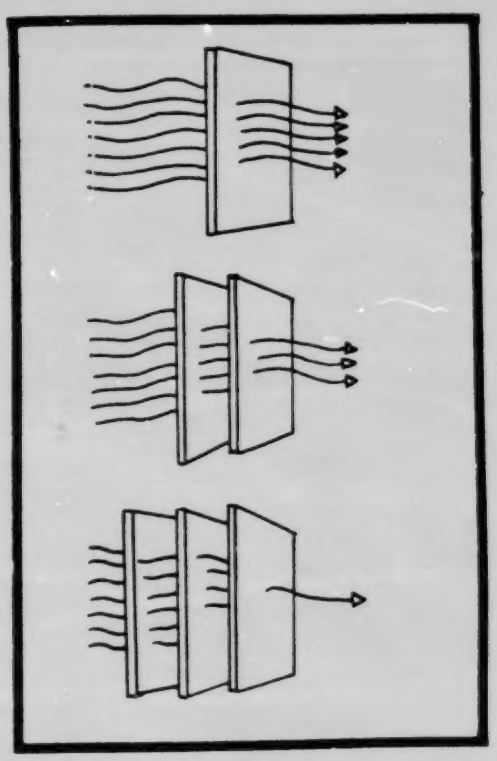


Figure 28. The Effect of Triple-Glazing.

The government study also found that wood window frames reduce heat loss about three percent more than aluminum frames.[23] This is simply because aluminum is a very poor insulator compared with wood. However, aluminum frames with thermal "breaks" are also effective because direct thermal conductance has been broken.[24]

The heat transfer through a door is determined by its R-value. A hollow-core wood door has a very low R-value and should not be used as an exterior door, but an insulated metal door, solid wood door, or the addition of a storm door is better. (See Figure 29.)

In addition to heat transfer through doors and windows, there is the very important problem of infiltration. As described previously, the use of weatherstripping, storm panels, and caulking reduces the infiltration around windows and doors and makes life more pleasant as well as less energy intensive. However, every time a door is opened, air moves in or out of the house. The type of door one has affects the amount of infiltration per opening.

ASHRAE has issued the following comparative values:

TYPE OF ENTRANCE	INFILTRATION--CUBIC FEET PER DOOR OPENING
Swinging door	900
Vestibule	550
Manual Revolving door	60
Motorized Revolving door	32

Of course, the fewer openings, the less infiltration.

The government study found that, in addition to reducing heat loss through the glass area, storm windows reduced infiltration by 50 percent.[25] The reduction of infiltration through doors with the addition of storm doors is not dramatic because the major source of the infiltration is the actual opening of the door. A more effective way to reduce infiltration through doors is by the use of an air lock--an air space large enough to permit the closing of one door before opening the second. This can be accomplished by using a vestibule or "mud room," as shown in Figure 30. Regardless of the type of window or door selected, it is important to select quality products that are well weatherstripped and tightly constructed to cut down air infiltration.

The wise use and placement of windows and doors can also reduce the heating and cooling load of a home. The fewer windows and doors, the less the load. Window areas should not exceed 20 percent of the total outside wall area or 10 percent of the interior floor area (except in some limited areas of the country).[26] (SEE ACTIVITY D.) Windows and doors should be protected from the forces of winter wind. Avoid placing openings on the winter windward side of the house; use baffles, plantings, and overhangs to protect them from the full force of rain, wind, and snow while permitting the maximum natural ventilation in warmer seasons. (Figure 31.) Solar radiation through windows and doors (particularly sliding glass doors) is

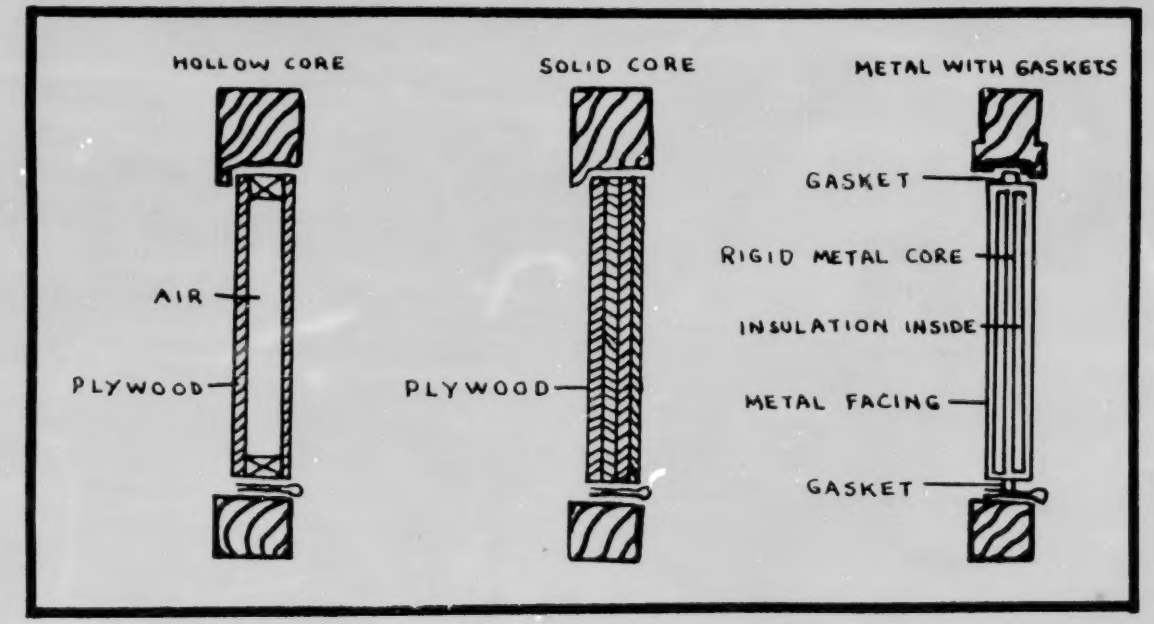


Figure 29. Construction of Doors.

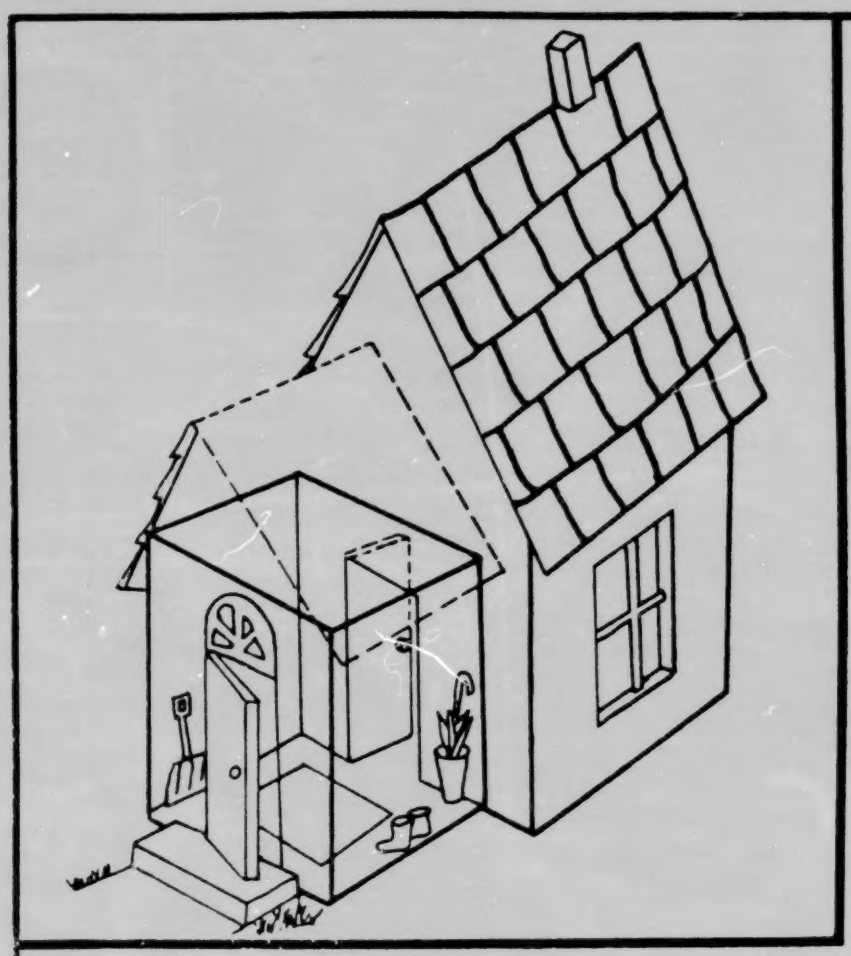


Figure 30. Vestibule Entry.

Figure 31. Protected Entry.

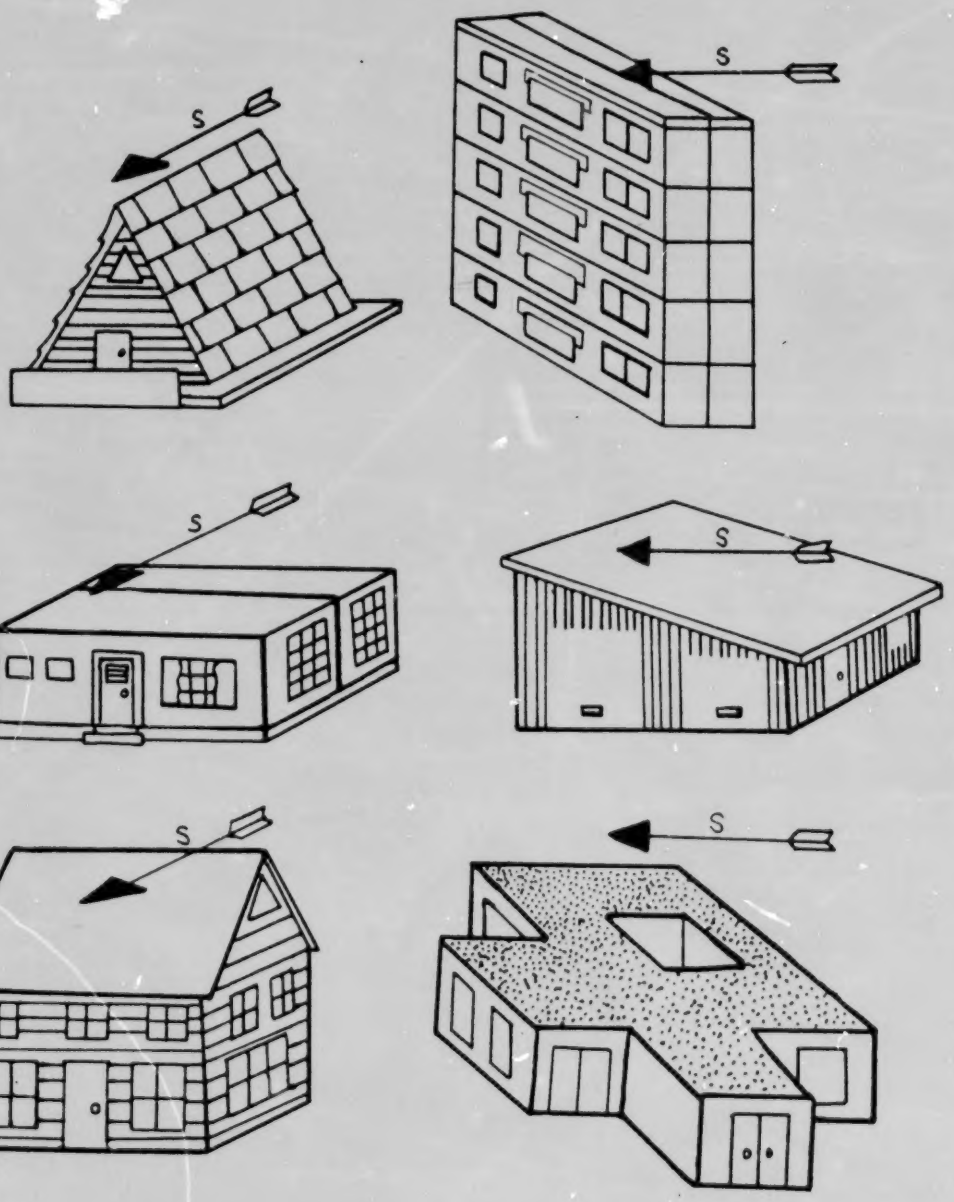


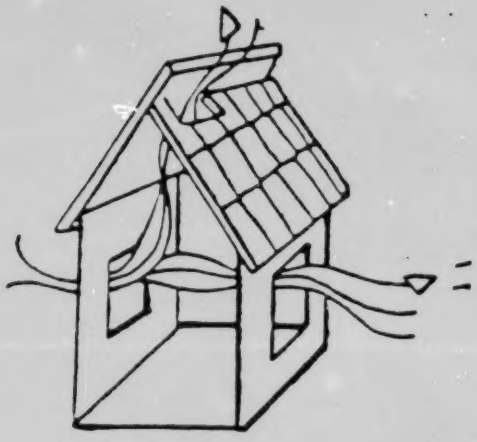
Figure 32. South-Facing Windows and Doors.

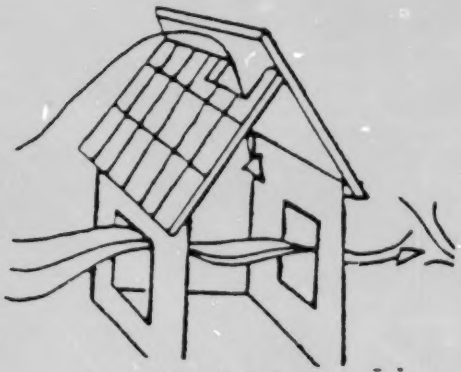
another important consideration. The use of roof overhangs can take advantage of radiation to heat in cool periods and avoid radiation in warm periods. The results of the government study have shown that the use of windows and doors on the north, south, east, and west walls have very different effects on the heating and cooling load of the home.[27] Windows and doors on the east and west side of the house represent great difficulty in controlling low-lying sun and should be shielded and limited in size and number. Openings on the north should be small and carefully designed to conserve heat since this side gets very little sun, particularly in the winter. South-facing windows and doors have the greatest potential for controlling the impact of the sun and utilizing its heat in winter, with the use of overhangs or awnings. If possible, the majority of a home's windows and doors should face south. Figure 32 illustrates these principles.

Windows and doors not only serve as a source of light and heat (from the sun), but also as a source of natural ventilation. Properly planned openings can provide cross-ventilation to cool the house in warm weather. The location and size of the openings can be manipulated to give the optimum ventilation for a specific need. Natural ventilation patterns are shown in Figure 33.

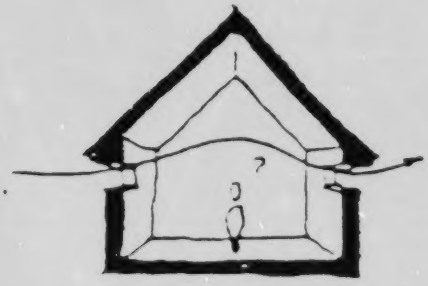
In conclusion, the heating and cooling load of a home may be reduced by:

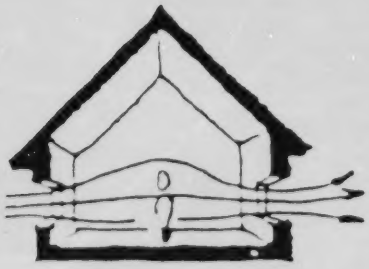
1. Installing storm doors and windows.
2. Properly weatherstripping and caulking windows and doors.
3. Reducing the area and number of windows and doors.
4. Using wood or insulated and/or thermal work metal for windows and doors.
5. Using a vestibule area.
6. Locating openings so as to avoid cold winds.
7. Properly locating and shielding openings to optimize the effects of solar radiation.
8. Properly locating openings for natural ventilation.



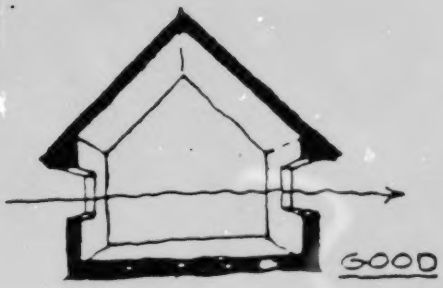


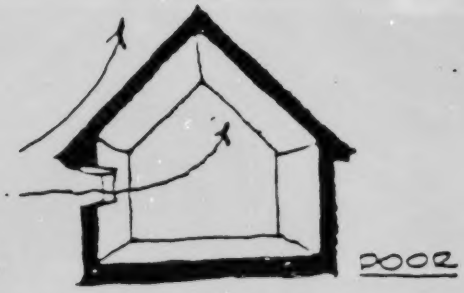
A combination of openings can direct air flow as desired.



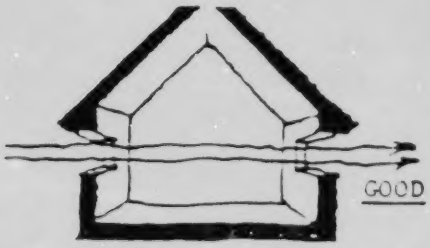


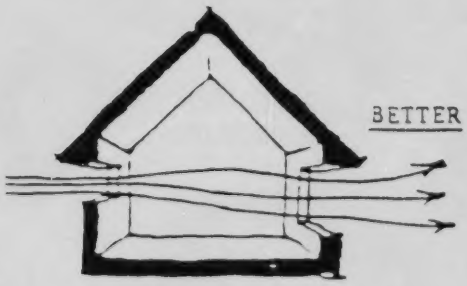
Openings placed lower in the wall surfaces allow better cooling.





Plan the openings to provide for cross-ventilation insofar as possible.





Good air flow occurs when the inlets and outlets are approximately the same size.

A larger area of outlet than of inlet will allow faster air flow and thus better ventilation.

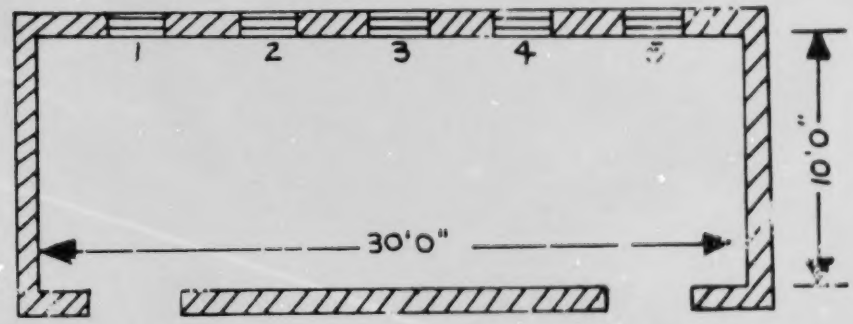
These examples emphasize placement of the windows, not the style.

ACTIVITY D — WINDOW AREA INVESTIGATION[26]

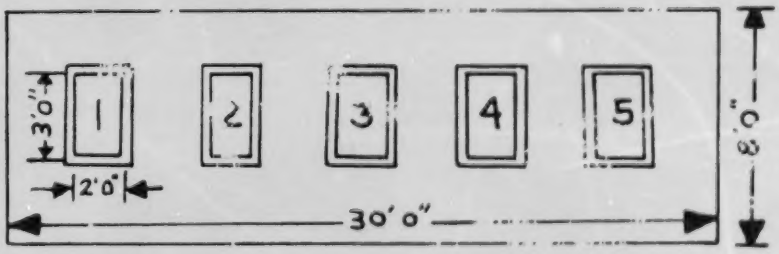
OBJECTIVE: TO DETERMINE THE PERCENTAGE OF SQUARE FOOTAGE OF WINDOW AREA TO TOTAL WALL AREA AND TOTAL FLOOR AREA.

Since glass has much less insulative value than a wall, it is wise to use as little glassed area (windows) as possible to conserve energy for cooling and heating. There are building code restrictions and guidelines for the amount of glassed area. 10 percent of the total square footage of floor space for the home and less than 20 percent of the total square footage of the exterior wall are generally accepted standards for residences.

It is a simple arithmetic procedure to determine if your home or classroom meets those guidelines. First try the 10-percent-of-the-floor method. In the example below, we see the square footage of the room is 300 square feet.



From the elevation, we see the total glassed area is 30 square feet.



To determine the percentage of glassed area you simply divide:

$$\frac{30 \text{ glassed area}}{300 \text{ floor area}} = .10 \text{ or } 10\%$$

Now try the 20-percent-of-total-wall-area method. In the example, the total wall area is 240 sq. ft. since 8' x 30' = 240 sq. ft. The glassed area is 30 sq. ft. Therefore, the percentage of glassed area is:

$$\frac{30}{240} = .125 \text{ or } 12.5\%$$

Using either method, the glassed area is within the guidelines.

Now determine if your classroom or home meets the guidelines.

Method I: 10% of floor area

Total Floor Area_____ sq. ft.
Total Glassed Area_____ sq. ft.

$$\frac{\text{glassed area}}{\text{floor area}} = \frac{\quad}{\quad} = \quad\%$$

Method II: 20% of wall area

Total Wall Area_____ sq. ft.
Total Glassed Area_____ sq. ft.

$$\frac{\text{glassed area}}{\text{walled area}} = \frac{\quad}{\quad} = \quad\%$$

Suggestions:

1. Try both methods in the classroom before trying to tackle your home.
2. This makes a good group activity.
3. This Activity may be used in conjunction with reading floorplans and measuring interior spaces.
4. Remember to measure only the *glassed* area of windows--not the frames, too.
5. Note that weather changes will also affect heating and cooling energy uses.

Walls[26]

In the single-family residence studied by the federal government, the walls contributed approximately 24 percent of the heating load and 14 percent of the cooling load.[17] The thermal resistance of a wall is determined by how readily heat passes through it. Heat is lost on cold days by conduction through the walls and by actual infiltration of cold air through cracks and openings. Heat is gained in the same manner with the additional effect of solar radiation. These types of heat transfer are shown in Figure 22.

Conduction and infiltration through walls can be reduced by using insulation, making walls air tight, and by minimizing the adverse effects of wind and sun. Uninsulated masonry and concrete walls are relatively poor thermal barriers; therefore, insulation must be added. Rigid or granular insulation is used in the masonry cavity or rigid insulation is applied to the interior of the wall. The frame wall is easier to insulate and can provide the same protection. It is important to remember that walls are easiest to insulate at time of construction. As illustrated in Figure 23, an energy conserving wall should have these elements:

1. A weather surface: to shed water and protect the other wall elements, prevent moisture and air infiltration.

2. Structural support: to support the wall and other building elements.

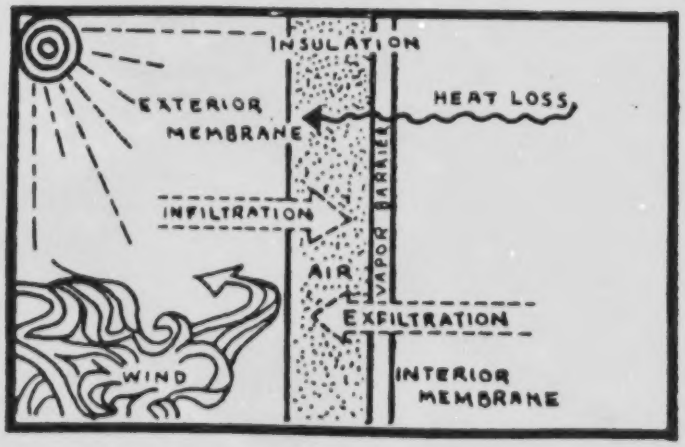


Figure 22. Heat Transfer Through a Wall.

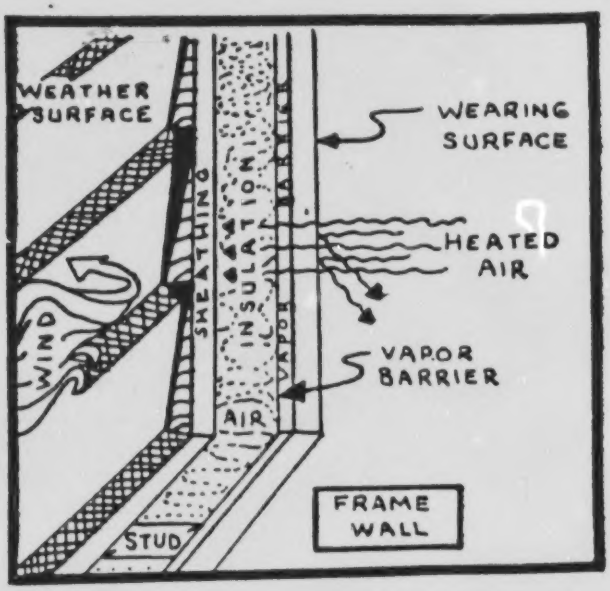
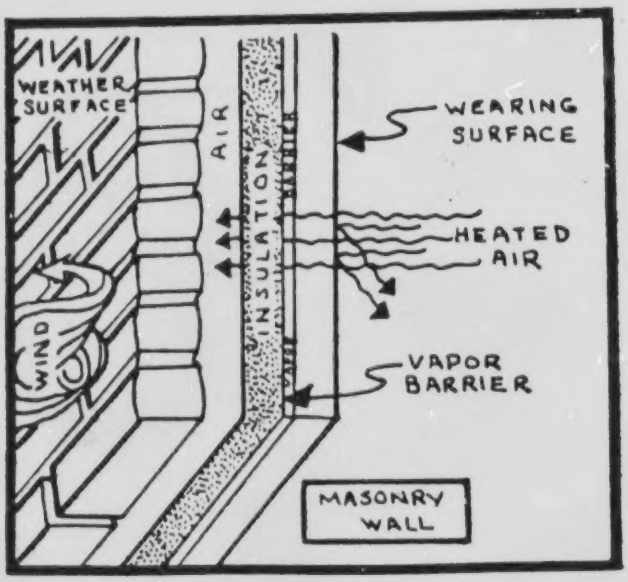


Figure 23. Energy Conserving Walls.



3. Insulation: to prevent conduction of heat.

4. Air space: to provide ventilation within wall elements and serve as increased insulation.

5. Vapor barrier: to prevent moisture from entering the wall and to prevent infiltration.

To control the effects of solar radiation, light paint or materials on exterior walls should be used in most areas.[18] Wooden trellises, horizontal and vertical louvered panels, or grills may be used to prevent solar heating of the house in warm climates, as illustrated in Figure 24.

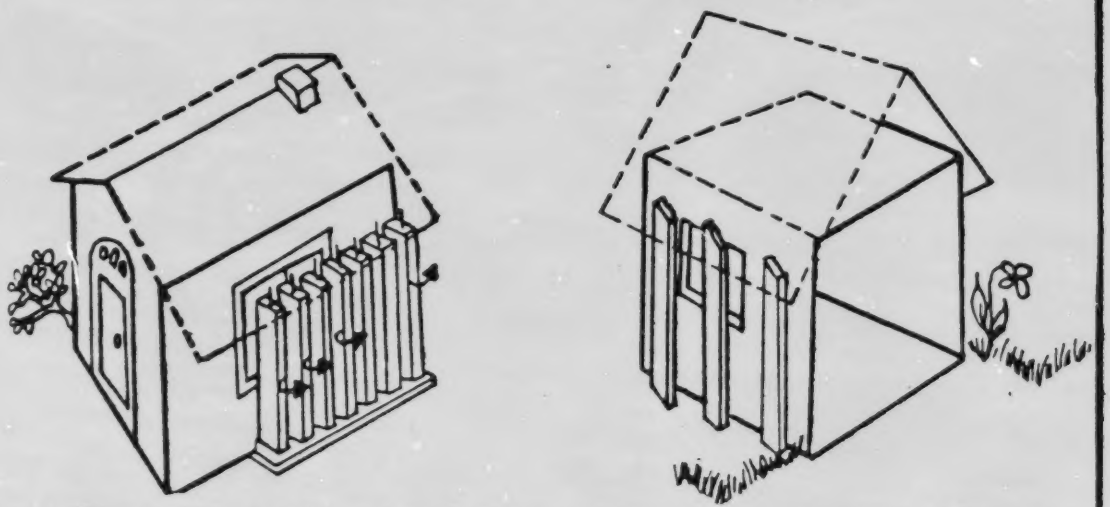


Figure 24. Exterior Sun Shades: Louvres *(left)* and Baffles *(right)*.

Building Materials:

All other things being equal, buildings employing heavyweight walls and roofs exhibit beneficial characteristics with regard to energy.

When sun shines through a window, its heat gain to the space is almost instantaneous. Similarly when sun shines on lightweight walls, the energy that it imparts to the wall is transmitted into the room in a short period of time. This is not very desirable in the summertime.

If the material is of a heavier weight, the heat will start through the walls but some will never reach the inside. If the temperature drops in the evening, the heat will reverse and go back to the cooler outdoors rather than go within the house, since heat goes from an area of higher concentration to an area of lower concentration.

Building materials have been rated as to the amount of heat they will conduct.

Infiltration

Infiltration is the passage of air into and out of a residence through a variety of openings (doors, windows, cracks, vents, dampers, etc.).

As was noted in the HUD single-family residence report on the heating and cooling of homes, infiltration was the largest load factor for both heating and cooling, about 55 and 42 percent, respectively.[14] The amount of infiltration varies greatly from house to house because of differences in construction and the habits of the occupants. ASHRAE (American Society of Heating, Refrigerating, and Air Conditioning Engineers) researchers determined that the optimum rate of infiltration for residences should be about one complete air change every 10 hours with no wind or indoor-outdoor temperature difference.[15] With differences in temperature and slight winds, the air change could be as great as 1.5 or one-and-a-half complete air changes per hour! Some people fear a "too tight" house that won't admit fresh air. This is not the case even in the tightest homes. Sometimes the interior air may seem stale; if it does, open a window for a few minutes. The number of door and window openings and closings, the use of exhaust fans, the use of fireplaces, the movement of air within the house all affect infiltration. Aside from these sources of infiltration are the narrow openings around doors and windows, as well as within ceilings, walls, and floors.

There are two approaches to decreasing infiltration. One is to foster conserving habits in occupants. The other is to seal cracks. Several tips for reducing infiltration are included below:

1. Keep all exterior doors--as well as those on garage, attic and basement--tightly closed and weatherstripped.

2. Close damper when fireplace is not in use.

3. Use exhaust fans sparingly.

4. Close central heating vents when using room air conditioner and vice versa.

5. Keep all windows tightly closed when heating or cooling equipment is operating.

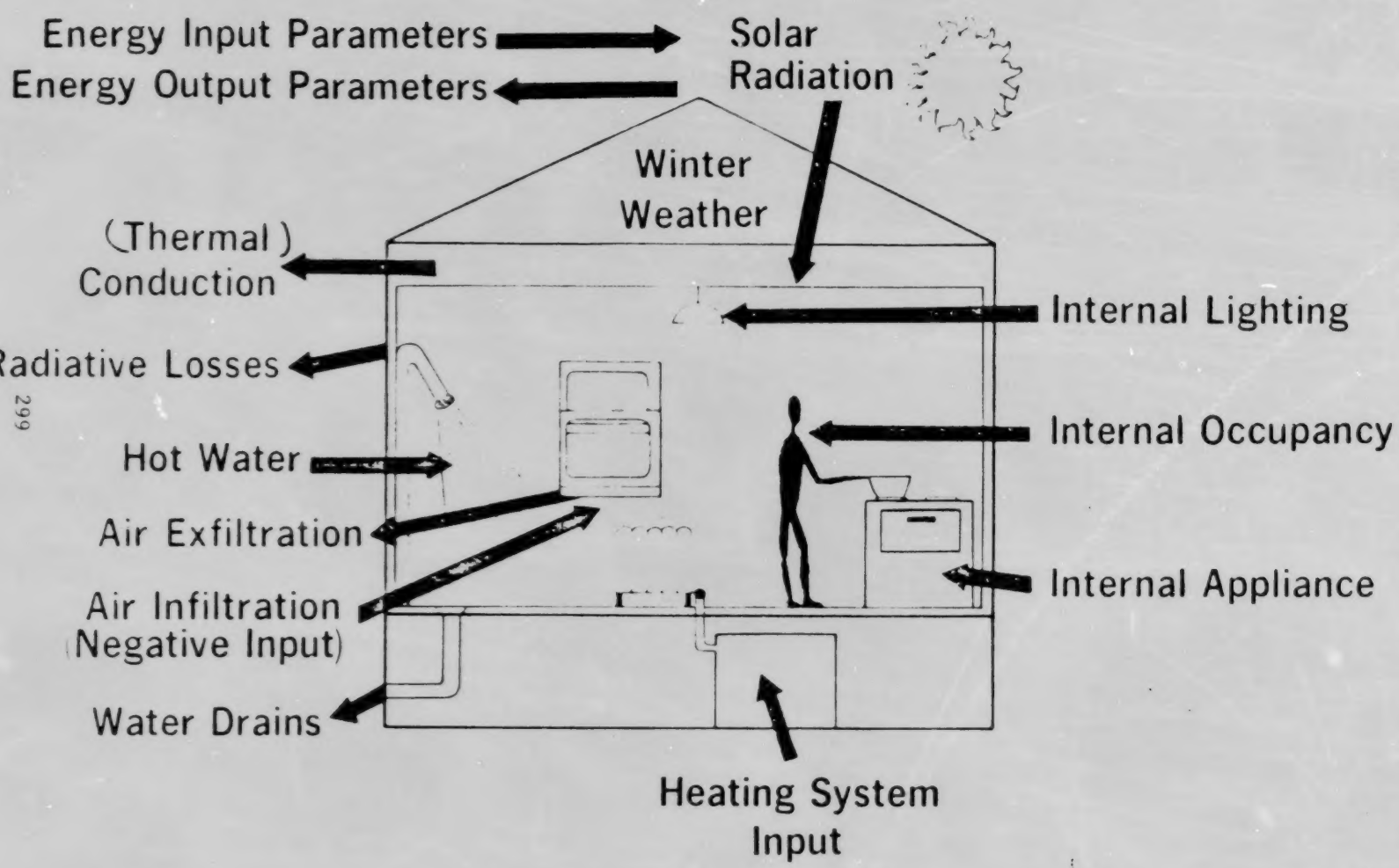
6. Use fireplaces on cool days but not cold days.

7. Plan ahead; make as few trips as possible in and out of exterior doors.

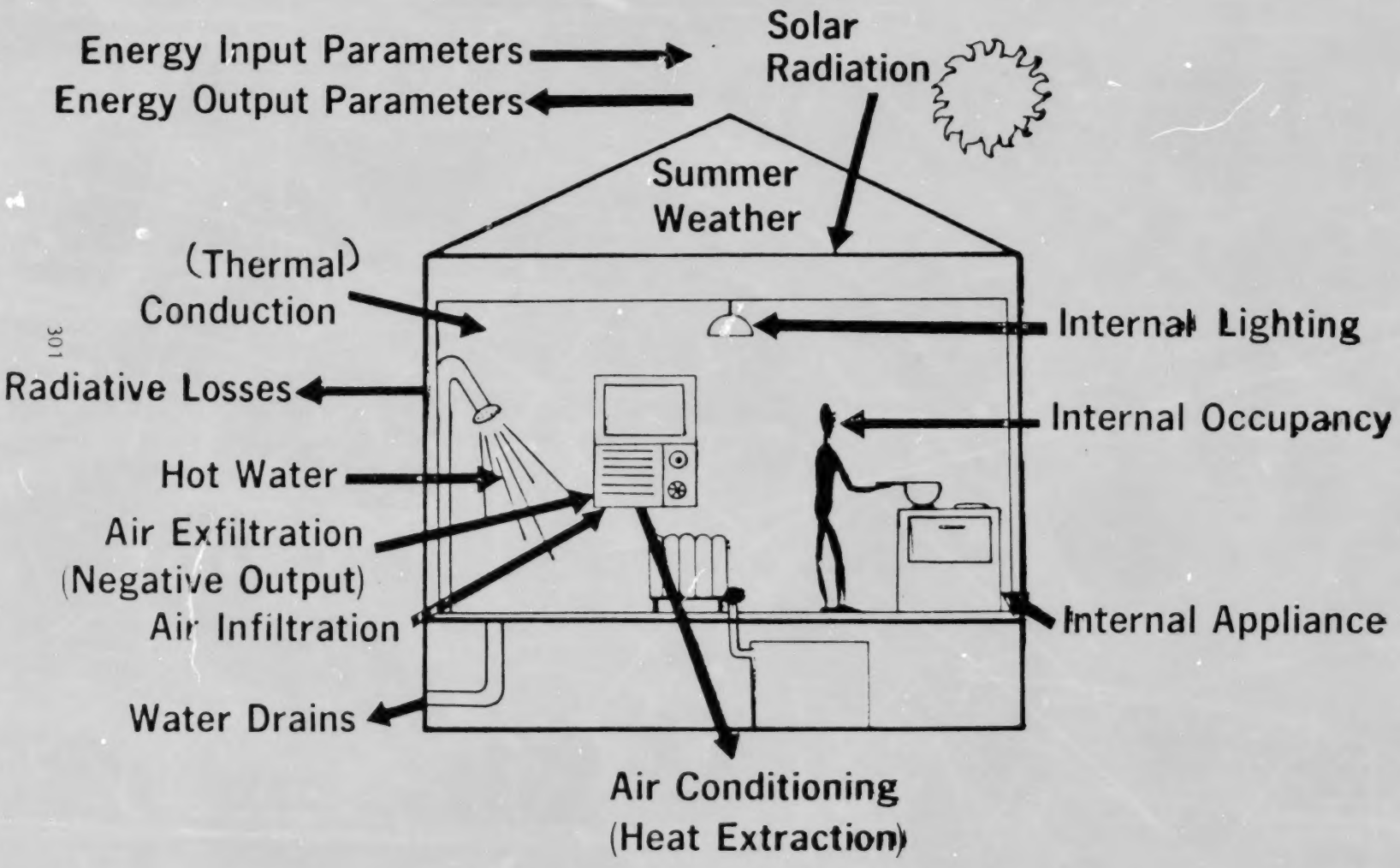
To seal openings, a number of measures may be taken, including weatherstripping, caulking, sealing, and painting. Weatherstripping closes off the space around doors or windows. Different types of weatherstripping are available. Most are inexpensive and easy to install.

Caulking is a putty-like material which is squeezed into cracks and openings with a pressure gun. The outer layer hardens and can be painted while the inner part stays soft and flexible to allow for expansion and contraction. Caulking should be used to seal cracks in walls and joints. All holes in exterior walls, roof, or flooring should be patched. Broken or cracked window glass should be replaced. All dampers and vent closures should be tight. Of course, the fewer windows and doors in a home, the less infiltration.

Energy Balance in Winter



Energy Balance in Summer



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.2 home energy guide[0]

weather stripping

cooperative extension, clemson university

INFILTRATION

Infiltration is air flowing inward through cracks around windows, doors, and along the baseboards of outside walls. These are major losses in most homes and are especially important during the coldest weather.

Preventative measures such as effective use of weather stripping materials of all kinds, taping, and caulking can greatly reduce the fuel cost and also improve occupant comfort. Some investigators feel the amount of fuel saved will be in the 10 percent range depending upon the circumstances of each individual dwelling.

All homes suffer some unnecessary heat loss, whether old or new, insulated or not. Heat escapes wherever two different materials join and through any opening. The major portion of this heat loss can be remedied by inexpensive, do-it-yourself jobs -- weather stripping, caulking, sealing.

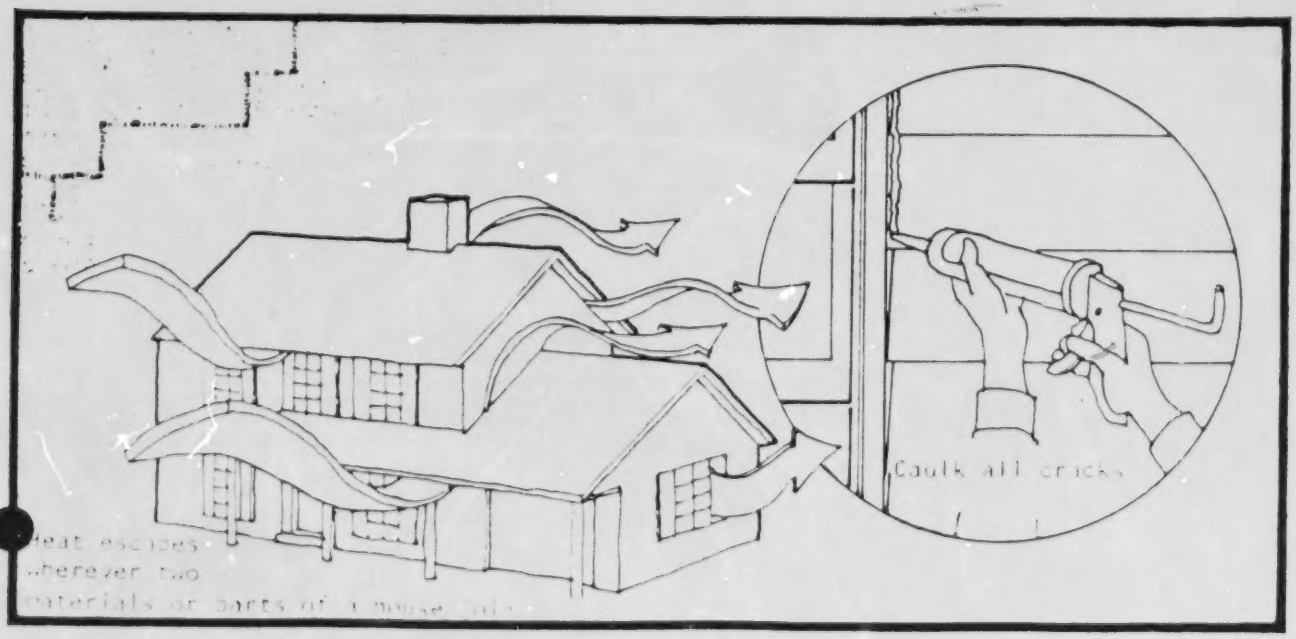
CAULKING

Caulk or seal all cracks thoroughly by applying a good quality caulking compound with a putty knife or caulking gun. On the outside of the house check:

- around window and door frames, sills, jambs
- around corners formed by siding
- between porches and main body of house
- around water faucets and electric outlets
- where chimney or masonry meets siding

On the inside of the house check:

- between foundation and sill plate
- around ceiling fixtures
- around water pipes and drains
- where furnace flue goes through attic
- around attic entry



- between heated and unheated areas, such as garages and crawl spaces

All cracks should first be cleaned to prevent premature loosening of the caulking. Deep or wide cracks should be filled with caulking cotton, sponge rubber, mineral wool, or "oakum".

WEATHER STRIPPING

In addition to caulking, weather strip all doors; windows and movable joints should be checked and a durable weather stripping material added wherever air leaks are found. Especially weather strip:

- around all loose-fitting window sash and casings
- around loose-fitting entrance doors
- around doors or any openings between heated and unheated spaces

TAPE

Paper masking type tape used to seal windows may be a desirable material for seasonal application. It can be removed each spring and leave window sash operable for the summer season.

COST

Weather stripping and caulking are do-it-yourself jobs. Caulking costs about $2.00 a window and $1.75 a door. Weather stripping costs about $2.00 a window and $6.00 a door. Check with local hardware dealers for specific instructions and type of weather stripping and caulking to be used for your particular job.

This material was assembled by Frank Hedden, Associate Professor, Agricultural Engineering, to assist with the general educational programs in the area of housing conducted by the Cooperative Extension Service of Clemson University. Dwayne Vernon, graduate student of Architecture, researched the subject matter and prepared the illustrations.

Reprinted October 1977

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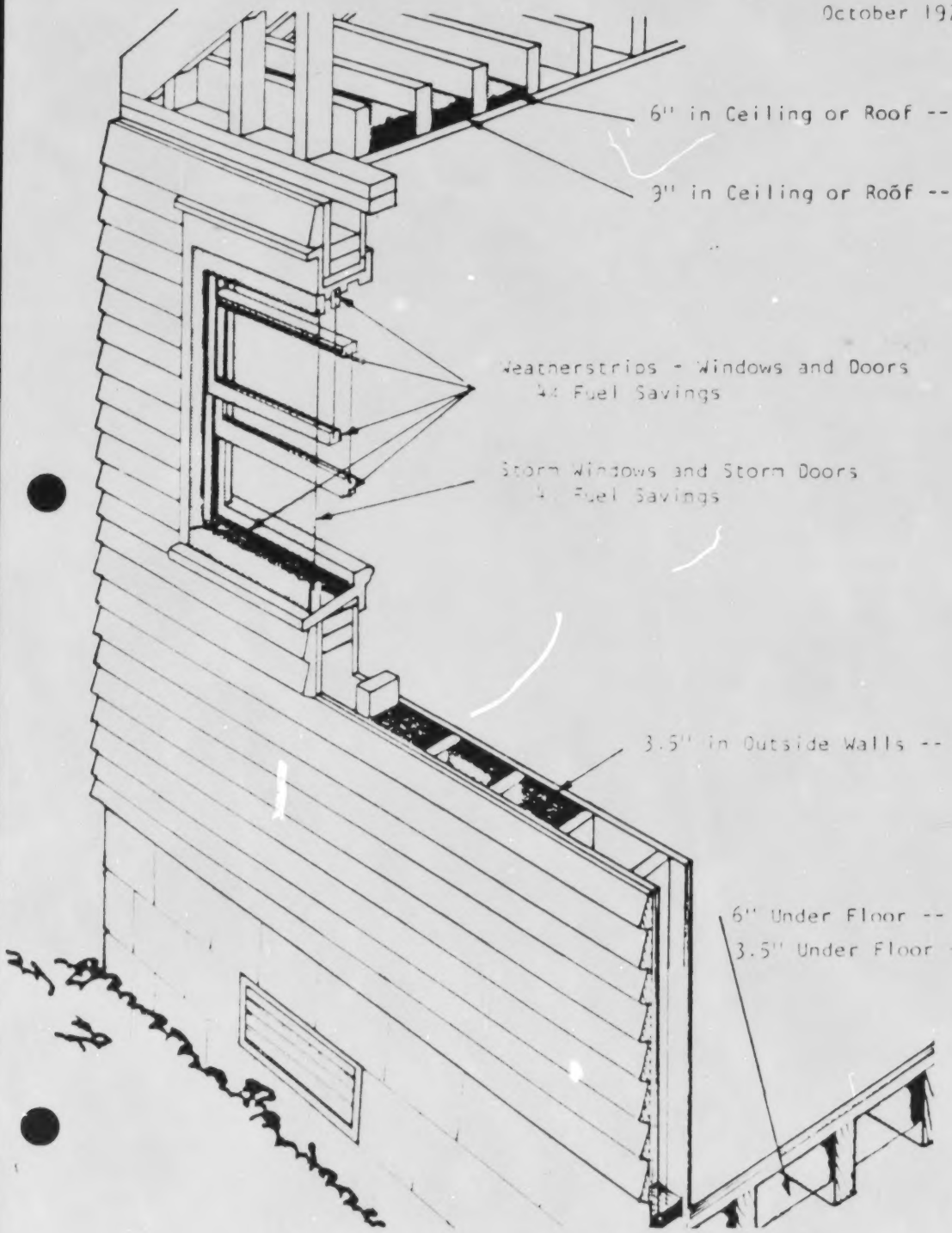
3 home energy guide

fuel savings

cooperative extension, clemson university

October 1977


6" in Ceiling or Roof -- 50% Fuel Savings
3" in Ceiling or Roof -- 52% Fuel Savings
Weatherstrips - Windows and Doors
4% Fuel Savings
Storm Windows and Storm Doors
4% Fuel Savings
3.5" in Outside Walls -- 3% Fuel Savings
6" Under Floor -- 13% Fuel Savings
3.5" Under Floor -- 11% Fuel Savings

FUEL SAVINGS BY INSULATION

The potential fuel savings indicated were based on a brick veneer house with 1600 square feet. Insulation, where used, is assumed to be rock wool, either loose filled or bat. Exact recommendations for a residence, either existing or under construction, should be developed in consultation with a reputable insulation contractor.

Obviously, the greatest potential for fuel savings would come from putting insulation over the ceiling; followed in order by underfloor, outside walls, installation of storm windows and doors and window and door weatherstripping.

This material was assembled to support the educational programs of the Cooperative Extension Service of Clemson University by Frank Hedden and Ernest B. Rogers, Jr., Associate Professors, Agricultural Engineering.

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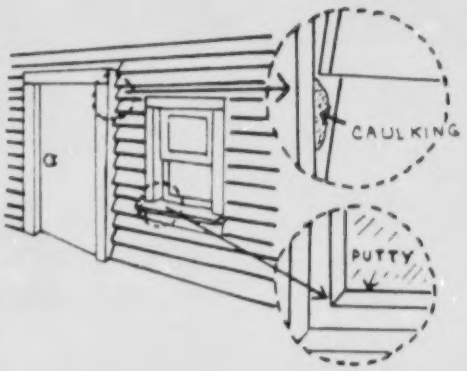
ACTIVITY U — WEATHERPROFING INVESTIGATION

OBJECTIVE: TO DETERMINE HOW MUCH, IF ANY, ADDITIONAL WEATHERPROOFING NEEDS TO BE ADDED TO YOUR HOME.

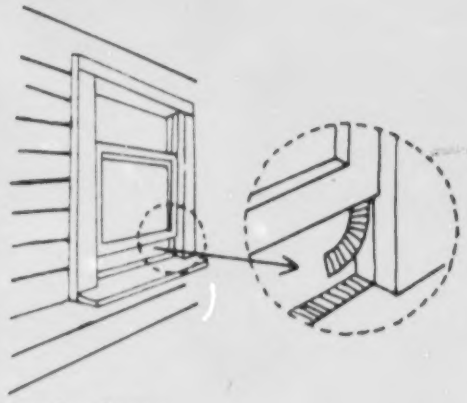
To reduce the heating and cooling costs in a home, it is important to reduce air movement in or out of the home. The cheapest, most effective way to reduce infiltration is with weatherproofing: caulking, putty, or weatherstrips. Below you will see illustrations of several locations where infiltration is likely to occur. Refer to the illustrations and use the checklist to determine the condition or existence of weatherproofing at your house.



1. WINDOWS

Check the circled areas of your windows.

- ☐ OKAY - Good, unbroken weatherstripping in all places with no drafts.
- ☐ FAIR - Weatherstripping damaged or missing in some places and minor drafts.
- ☐ POOR - No weatherstripping at all and very drafty.

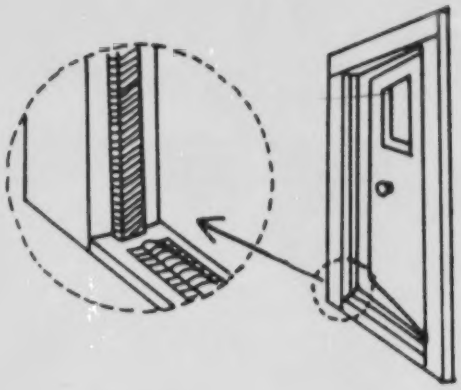


2. DOORS

Check the circled parts of the door.

- ☐ OKAY - Good, unbroken weatherstripping with no drafts.
- ☐ FAIR - Weatherstripping is missing or damaged in places with minor drafts.
- ☐ POOR - No weatherstripping and very drafty.

Conclusions:



2. AREA AROUND THE DOORS AND WINDOWS

Look at a typical door and window area and check the circled areas carefully.

- ☐ OKAY - Caulking fills all cracks around the door frame and the putty around the window is unbroken and solid; no drafts.
- ☐ FAIR - Putty and caulking are cracked or missing, causing minor drafts.
- ☐ POOR - No caulking at all and the putty is in very poor condition causing very bad drafts.

Conclusions:

If you checked fair or poor for any of the three areas, then the weatherstripping, caulking, or putty needs to be replaced. If all areas are okay, then you don't need caulking, weatherstripping, or putty.

UNIT 10.1 ADDITIONAL INSULATION[26]

OBJECTIVE: TO ENABLE THE TEACHER OR STUDENT TO DETERMINE IF ADDITIONAL INSULATION IS NEEDED IN A HOME.

Probably the single most important way to improve energy efficiency in the home is by adding insulation.[2] Most homes are underinsulated; some are not insulated at all! As shown in Figure 59, walls, floors, and ceilings should be insulated. Insulation can be easily added by the occupant in most cases. It is usually easiest and most effective to install insulation above the ceiling. Next easiest is under the floor. The most difficult place to add insulation is in walls. Furthermore, the addition of insulation is cost-effective; that is, it will more than pay for itself in energy savings. The following steps should be followed when insulating your home.

1. Determine how much insulation is desirable for the particular climatic region in which the home is located. This is most easily accomplished by asking the local utility company or the State Energy Office. Examples of currently recommended minimum R-Values (ED. NOTE: R-Value is defined as the amount of resistance of a material to heat flow. The higher the R-Value the higher the resistance to heat flow.) are listed below:

	FHA Minimum Standards for Gas Heat	National Mineral Wool Assoc. for Oil Heating	TVA Electric Heating	Studies Based on Minimum Life Cost	Owens Corning
Ceilings	R-19	R-19 or R-22*	R-19	R-30	R-38
Walls	R-11	R-11 or R-13*	R-11	R-20	R-19
Floors over unheated space	---	R-11	R-11	R-20	R-22

*special situations

2. Translate the R-value into insulation thickness. As mentioned, insulating materials have differing abilities to reduce the transfer of heat. This is illustrated in the table on the following page:

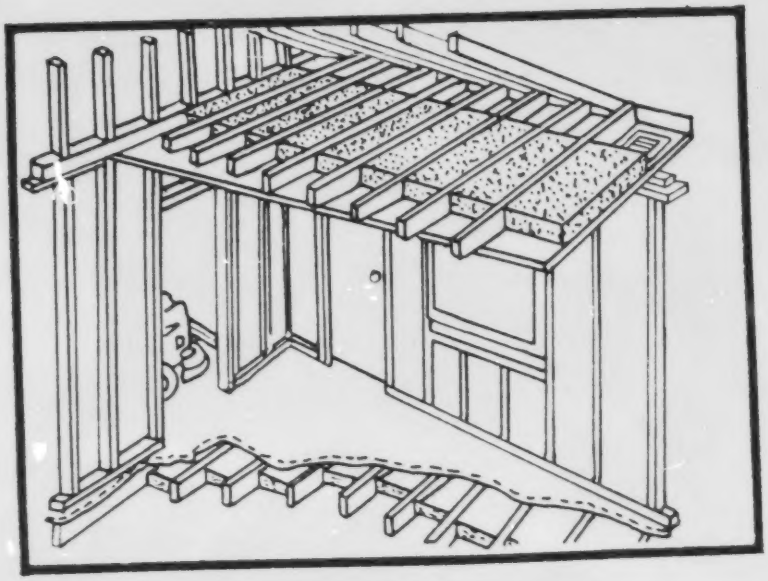


Figure 59. Wall, Floor, and Ceiling Insulation.

Material Thickness	Insulation: Batts or Blankets: Glass Fiber	Batts or Blankets: Rock Wool	Loose Fill (Poured-in): Glass Fiber	Loose Fill (Poured-in): Rock Wool	Loose Fill (Poured-in): Cellulose Fiber
1 inch	R-3.38	R-3.66	R-2.20	R-2.75	R-3.66
2 inches	R-6.76	R-7.32	R-4.40	R-5.50	R-7.32
3 inches	R-10.14	R-10.98	R-6.60	R-8.25	R-10.98
4 inches	R-13.52	R-14.64	R-8.80	R-11.0	R-14.64
5 inches	R-16.90	R-18.30	R-11.0	R-13.75	R-18.30
6 inches	R-20.28	R-21.96	R-13.20	R-16.50	R-21.96
7 inches	R-23.66	R-25.62	R-15.40	R-19.25	R-25.62
8 inches	R-27.04	R-29.28	R-17.60	R-22.0	R-29.28

Note: R-value is marked on insulation.

3. Determine the level and type of *existing* insulation, and translate into R-values. As an example, the following information has been determined for a home in Knoxville, Tennessee:

Location	Type of Existing Insulation	R-value of Existing Insulation	R-Value Recommended for Location	Additional R-value needed
Ceiling	4" loose rock wool	11	30	19
Walls	2½" fiberglass batt	8.45	20	11.55
Floor	none	--	20	20

4. Determine what additional insulation is needed using the format of the table above. In the previous example, the ceiling would require seven additional inches of loose rock wool; the floor would require six inches of fiberglass batt; and the walls could not be further insulated due to a lack of space. The additional insulation may be installed by the occupant or by a contractor.

UNIT 10.2 UPKEEP ON HOME

OBJECTIVE: TO ENABLE THE TEACHER OR STUDENT TO RECOGNIZE THE UPKEEP PRACTICES REQUIRED TO MAINTAIN AN ENERGY EFFICIENT HOME.

It is not enough to start with an energy efficient home and sit back and relax. As the home ages, cracks and crevices form and infiltration increases; insulation tends to settle and degrade. Since the soiling process is a never-ending problem, filters must be changed, windows cleaned, and heating and cooling elements cleaned periodically. In addition, heating, ventilation, and air-conditioning (HVAC) systems, plumbing, and lighting must be maintained.

Every year or two the following steps should be taken to maintain a home's energy efficiency:

1. Check the interior and exterior of the home for cracks and crevices; fill or seal them.

2. Check the weatherstripping and caulking around windows, doors, and chimneys; repair if necessary.

3. Have the heating, ventilation, and cooling systems checked; adjust oil furnace burners at least once a year to avoid wasting fuel.

4. Paint interior and exterior if needed to seal small cracks.

5. Examine the chimney for cracks and deterioration; repair if necessary.

Each fall and spring:

1. Make sure furnace and air conditioning filters are clean. Dirty filters waste fuel and money and will shorten the life of the equipment. Filters should be checked every month if possible.

2. Clean windows to take advantage of solar radiation.

3. Dust radiators and baseboard units thoroughly; dust reduces the efficiency of a unit.

4. Check for water leaks or drips; hot water loss results in both an energy loss and a water loss.

ACTIVITY T INSULATION INVESTIGATION[26]

OBJECTIVE: TO FAMILIARIZE STUDENTS WITH AVAILABLE TYPES OF INSULATION AND THEIR LABELING.

There is a wide variety of insulation available today. They have different uses, R-values, and forms. As a class, try to collect five to ten different types and develop an information display indicating the R-values and uses. Try to obtain the following types: (1) loose-fill mineral wool; (2) loose-fill polystyrene beads; (3) batt mineral wool without vapor barrier; (4) batt mineral wool with vapor barrier; (5) rigid foam board; (6) cellulose fiber; (7) vermiculite or perlite. Look on the label for the R-value and use. See the *Sample Label* below:

NAME OF MANUFACTURER

Loose Insulation

Weight of insulation per bag: 30 lbs. The manufacturer recommends these maximum coverages at these minimum thicknesses to provide the levels of installed insulation resistance (R) values shown:

R Value	Minimum Thickness	Maximum net Coverage
To obtain an insulation resistance R of:	Installed insulation should be not less than:	Contents of this bag should not cover more than:
R-24	8 1/4 inches thick	28 square feet
R-19	6 1/2 inches thick	35 square feet
R-13	4 1/2 inches thick	50 square feet
R-9	3 1/4 inches thick	75 square feet

Suggestions:

1. Seek insulation from building supply stores, building contractors, and insulation suppliers.
2. Your local utility company may have an insulation display and demonstration which they would present at your school.
3. Be careful with fiberglass insulation--it is glass and can penetrate the skin causing a great deal of irritation.

ACTIVITY S RESIDENTIAL ENERGY CHECKLIST[26]

OBJECTIVE: TO PROVIDE AN EASY AND QUICK SCAN OF THE HOME TO REVEAL POSSIBLE SOURCES OF ENERGY WASTE AND POTENTIALS FOR ENERGY CONSERVATION.

There are many ways to save energy in the home; some cost money, but many are absolutely free. They all save the occupants fuel and money as well as keep them comfortable. HUD estimates that each year American homes waste the equivalent of about 223 million barrels of oil which could be saved without sacrificing comfort. Energy can be saved by adding insulation to homes, by proper unkeep of homes and appliances, and by minor interior alterations.

The following energy checklist can be used by you (the student), your parents, and relatives as a handy guide to systematically search for residential energy waste and potentials for conservation. The checklist does not attempt to quantify the energy loss, nor estimate the cost to aleviate the problems. In some cases, it might not be practical to try to eliminate the waste, but rather to reduce it or its impact.

RESIDENTIAL ENERGY CHECKLIST

House: The Shell	yes	no
1. Are plants properly located around the house to provide a break against wind and shade against unwanted sun?		
2. Are drapes and furniture located so they do not obstruct heating, air-conditioning or ventilation?		
3. Are draperies insulated?		
4. Do draperies fit snugly around the window?		
5. Are exterior house doors closed quickly after use?		
6. Are lights and appliances turned off after use?		
7. Do you have storm windows and doors?		
8. Are all doors and windows properly caulked and weatherstripped?		
9. Are draperies and shades closed at night and on cloudy, windy days during the heating season?		
10. Are draperies opened to admit sunlight on sunny days in the heating season?		
11. Are draperies and shades closed on sunny days during the cooling season?		
12. Is the attic ventilated?		
13. Is the attic insulated to 6-8"?		
14. Are the walls insulated?		
15. Do floors exposed to unheated or cooled air have from 2-3½" of insulation?		
16. Is the fireplace damper closed when not in use?		
17. Is the den, gameroom or family room oriented to the south?		
18. Is the house shaded from the western sun?		

	yes	no
19. Does your home have window area equivalent to 10% or less of its square footage?		
20. Is your home sealed from drafts? Is it free from cracks and holes?		
21. Does your home have fluorescent lighting where appropriate?		
22. Does your home have wall-to-wall carpeting?		
23. Do all windows have drapery, shades, blinds, shutters or other covering?		
Environmental Control		
24. Are ducts, radiators or air-conditioners closed off in unused rooms or closets?		
25. Are hot water pipes insulated in unheated and uncooled spaces?		
26. Are air ducts insulated in unheated and uncooled spaces?		
27. Is the thermostat set at 65°F or below during the heating season?		
28. Is the thermostat set at 78°F or above during the cooling season?		
29. Are heating and cooling filters clean?		
30. Is the thermostat turned back at night?		
31. Are windows and doors tightly closed while mechanically heating or cooling?		
32. Is an attic fan used in the summer?		
33. Do thermostats indicate correct temperature settings?		
34. Is an outside air-conditioning unit located on the shady (north) side of the house?		
35. Is the water heater insulated?		
36. Is the water heater temperature setting at 140°F or less?		

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	yes	no
37. Is the air-conditioning unit properly sized for your needs?		
38. Do you have a heat pump?		
39. Do you use natural ventilation as much as possible?		
40. Are radiators and other heating or cooling equipment clean and dust free?		
41. Is the water heater located in a heated space?		
Housing Selection		
42. If you live in an apartment, is it an "inside" apartment?		
43. If you live in a mobile home, does it have a "skirt"?		
44. If you live in an older home, have its plumbing, wiring, insulation and chimneys been checked by "experts"?		
Food		
45. Is the frost on the refrigerator and freezer less than ½ inch thick?		
46. Is the refrigerator set at $40^{o}F$?		
47. Is the freezer set a $0^{o}F$?		
48. Are gaskets around refrigerators and freezers tight?		
49. Is the oven used to bake more than one food at a time?		
50. Is the gasket around ovens tight?		
51. Are frozen foods thawed completely before cooking?		
52. Is the cooking range turned off immediately after use?		

	yes	no
53. Are dishes washed only when there is a full load?		
54. Are dishes allowed to air dry?		
55. Are appliances clean and dust free (particularly cooling coils)?		
56. Is the oven never used as a dryer or heater?		
57. Are flat bottom pots and pans used?		
58. Is a timer used to avoid over-cooking?		
59. Are pots covered during cooking?		
60. Is as little water as possible used during cooking?		
61. Is the heated dry cycle on the dishwasher not used?		
Clothing		
62. Does your family dress warmer in cool weather to avoid mechanical heating?		
63. Does your family dress cooler in warm weather to avoid mechanical cooling?		
64. Are clothes washed only when there is a full load?		
65. When washing, is cold or warm water used when possible?		
66. Are clothes line dried when possible?		
67. Are most of your family's clothes wash-and-wear, permanent press to avoid dry cleaning and ironing?		
68. Are clothes always rinsed with cold water?		
69. Is the washer located near the water heater?		
70. Is the dryer lint screen cleaned after each load?		

Personal Care	yes	no
71. Do the members of your family take short showers or use only small amounts of water for tub baths?		
72. Are all water faucets repaired and not leaking?		
73. For washing, shaving or make-up is the lavatory filled rather than allowing water to run?		

Entertainment

74. Are entertainment devices turned off when not in use?		
75. Do members of your family try to entertain themselves rather than rely on devices?		

--If you answered with 65 or more yes's, you are truly an energy conserver and will make a good conservation advocate.

--If you answered with 55 to 65 yes's, you are energy conscious but lack will-power or drive.

--If you answered with 45 to 54 yes's, you are wasting energy but with minor changes could make a conserver.

--If you answered with 35 to 44 yes's, you are an energy waster and should make an all-out effort to reform!

--If you answered with less than 35 yes's, you are making an effort to waste energy and should consider the long range and immediate effects!!

Suggestions:

1. Distribute these checklists school-wide.
2. Try a before and after approach to using the checklist. Check before your conserving effort and after.
3. Survey students to see if their families are generally conservative or not.

R-Values for Common Building Materials

Thermal resistance is an indication of the ability to retard heat flow rather than the ability to transmit heat. The R-value of home often used building materials are listed below.

Material	Description	R-Value
Finish Flooring Materials	Carpet and fibrous pad	2.08
	Terrazzo (1 in.)	.08
Building boards for subflooring, sheathing	Plywood - 1/2''	.62
	Plywood panels - 3/4''	.93
	Particleboard - (Med. density per inch)	1.06
Building Paper	Vapor barrier - permeable felt	.06
	Vapor barrier - seal, plastic film	Negligible
Masonry	Brick, common (per inch)	.20
	Concrete blocks - sand & gravel, 3 oval core 4''	.71
	8''	1.11
	12''	1.28
Roofing	Asbestos cement shingles	.21
	Wood shingles	.94
Siding	Asbestos cement - 1/4'' topped	.21
	Wood, bevel - 1/2 x 8'' lapped	.81
	3/4 x 10'' lapped	1.05
	Wood, plywood - 3/8'' lapped	.59
	Aluminum oversheathing hollow-backed	.61

SOUTH CAROLINA

PASSIVE SOLAR HOME DESIGN:

LOW COST ENERGY EFFICIENT OPPORTUNITIES[24]

WHAT IS WANTED?

A passive solar home is one which is kept relatively comfortable by using natural cooling and heating opportunities, instead of depending solely on fossil fuel-consuming mechanical devices. The concept of minimum use of fossil fuel heating and cooling systems is not new. With the advent of sophisticated mechanical air conditioning and heating systems, and the availability of inexpensive fossil fuels in the '40s and '50s, builders began bypassing passive techniques. Today's homes are usually designed to utilize mechanical air conditioning and fossil fuel systems rather than natural or passive heating and cooling techniques. As energy costs rise we again recognize traditional passive building techniques and we develop new methods.

Many of the design techniques described in the following pages are old ideas that have been pushed aside and forgotten during energy-carefree years. Although most of the designs are a comfortable mix of the old and the new, they all have one thing in common--conservation of energy through thoughtful design.

All these heating techniques must be used, of course, in combination with proper house insulation, and can be supplemented by conventional systems.

Since some of the cooling and heating techniques may not be compatible, the homeowner must make some value judgements.

This unit is drawn directly from Florida Solar Energy Center Designing With the Environment.

WHAT IS IT LIKE HERE?

Traditional residential construction evolved from an understanding and appreciation of the local climate, and produced comfortable housing before the introduction of central heating and air conditioning. Wide shading porches, high ceilings, floor-to-ceiling openings, elevated living floors, ventilation belvederes, window shutters, and internal zoning are all successful responses to climate that were learned through generations of building.

The region, ranging from the flat coast to the mountains is relatively temperate with four distinct seasons, including a very pleasant spring and fall. Though the summers are humid and can be hot, and winters are sometimes cold, comfortable days are possible at any time of the year. Rainfall is heavy, including summer thunderstorms and possible tropical storms. Ventilated indoor spaces, if shaded and screened, can take advantage of land and sea breezes and be comfortable a large part of the year. With these factors as a basis, priorities and principles have been developed for energy-conserving residential design in this area.

This unit is drawn directly from Regional Guidelines for Building Passive Energy Conserving Homes, which provides information more detailed than included here.

HOW TO DESIGN FOR THIS CLIMATE

Energy conservation is most effective when the specific needs of this climate are addressed. On the next pages a framework of general building guidelines is presented. Each design priority is illustrated with regional residential examples, starting with building siting, orientation, form, enclosure, and opening design.

FLOOR PLANS FOR PASSIVE SOLAR HOMES[24]

FIRST PRIZE WINNERS -- MARTIN DAVIS AND JOHN JACQUES
POST OFFICE BOX 1062
CLEMSON, SOUTH CAROLINA 29631

This design was unique amongst all the entries because of its strong relationship to the Charleston architectural environment. Basically, the house relies on a heavy mass, central to the house, for storage and as a central ventilation shaft. Additional mass is located under the floor, in the crawl space.

For heating, the home relies on large south facing windows plus the lower level greenhouse. It was felt that restrictive lot lines might reduce the amount of solar energy collected at this lower level, and that additional collection might be sought at the second level. Heat, once collected, is moved through the house naturally and enhanced by means of a mechanical recirculation duct in the central mass.

For cooling, exterior shading devices are used on the inclined glazing of the greenhouse. Large interior spaces, two to three stories in height, allow heated air to rise and exit through the central air tower.

The following illustrations indicate:

PERSPECTIVE	-	View showing entry porch greenhouse and solar chimney.
FIRST FLOOR PLAN	-	Shows air lock entry, greenhouse, centrally located solar chimney and emphasis on exterior living spaces.
SECOND FLOOR PLAN	-	Shows open space in the center of the house which allows heated air to rise and be vented through the solar chimney.
SECTION	-	Illustrates the emphasis on the greenhouse for heat collection and the solar chimney for heat venting.

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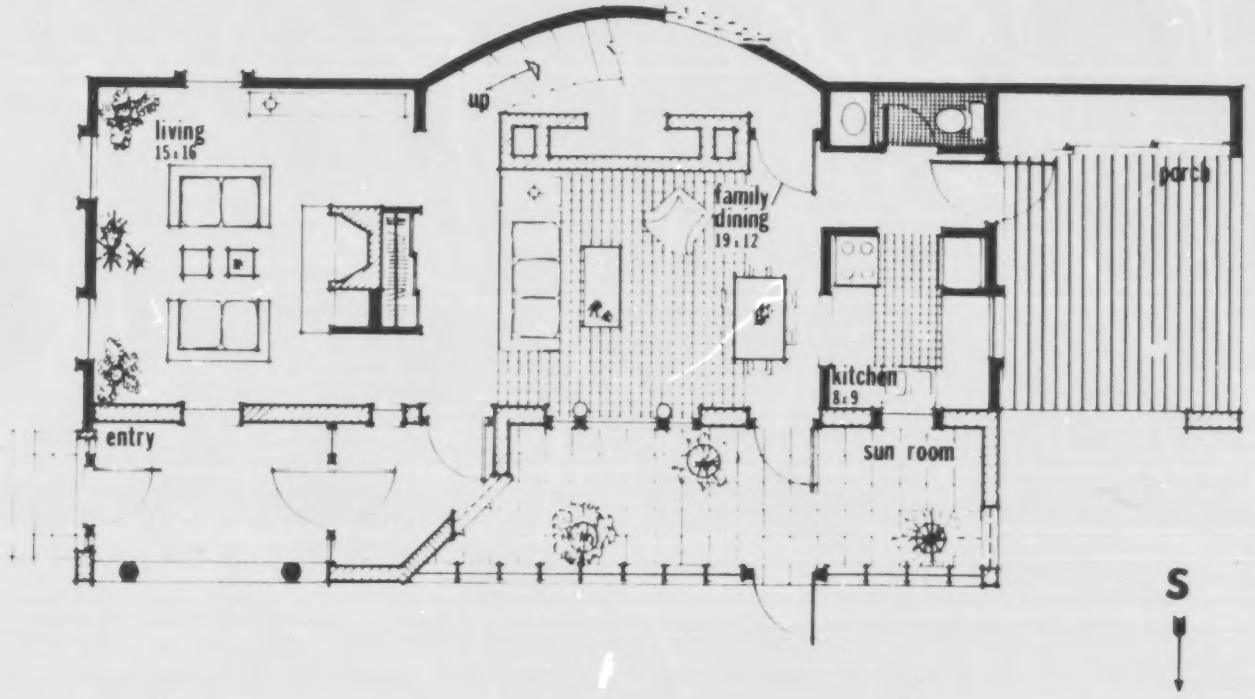
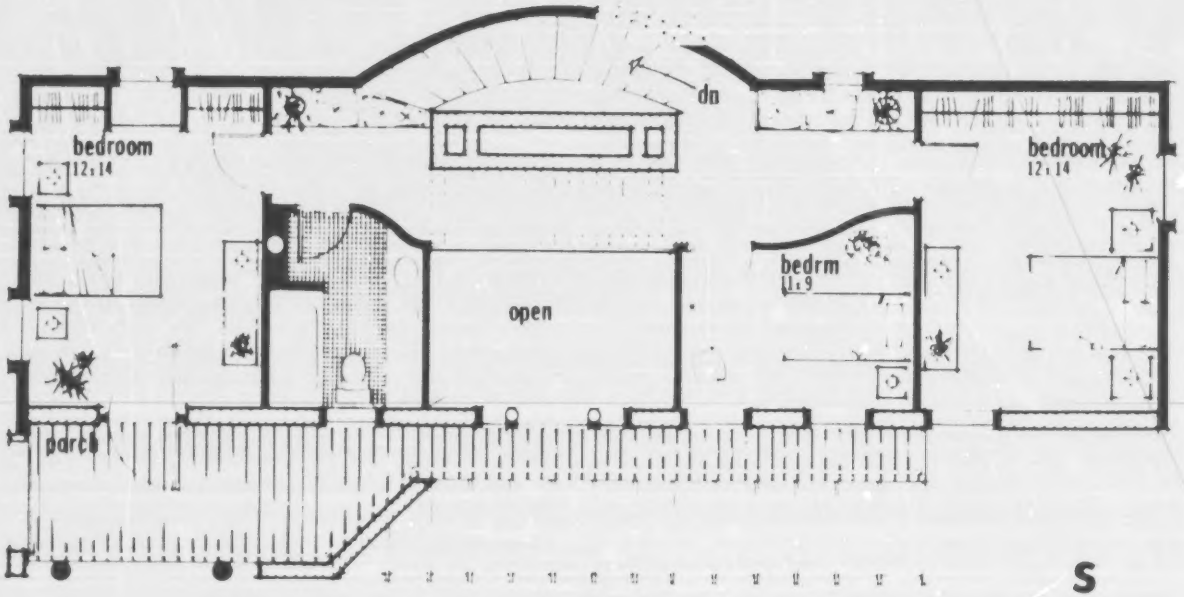
DAVIS/JACQUES PERSPECTIVE



DAVIS/JACQUES FIRST FLOOR



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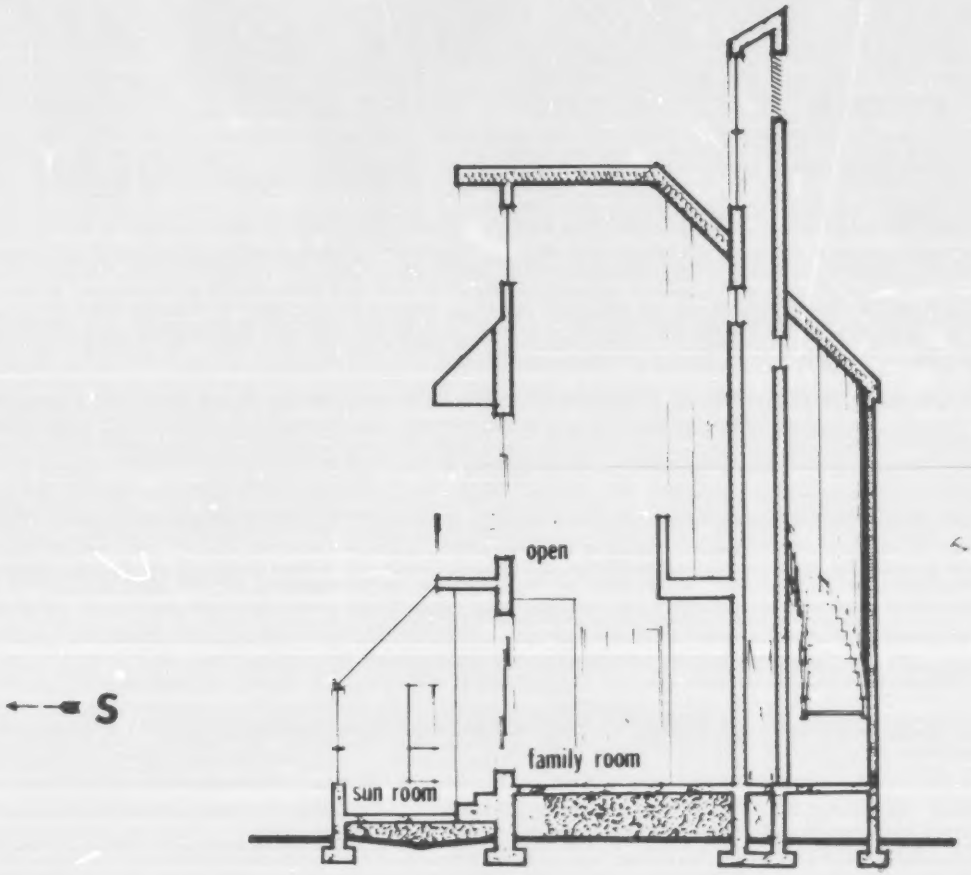
DAVIS/JACQUES SECOND FLOOR



DAVIS/JACOUES SECTION

FLOOR PLANS FOR PASSIVE SOLAR HOMES[24]

FIRST PRIZE WINNERS -- MIKE FUNDERBURK AND JOHN MEACHEM
SUNSHELTER DESIGN
1209 HILLSBORO STREET
RALEIGH, NORTH CAROLINA 27603

This design relies on good siting and traditional building techniques to reduce summer heat buildup as well as minimized cross ventilation to remove internal heat gains. Ceiling mounted paddle fans may be used in conjunction with natural breezes to enhance air movement within the house.

Special attention was paid to the development of exterior living and sleeping porches allowing maximum utilization of exterior areas.

Reflective roofing materials reduce heat buildup. The solar chimney can assist in the removal of excess heat within the greenhouse.

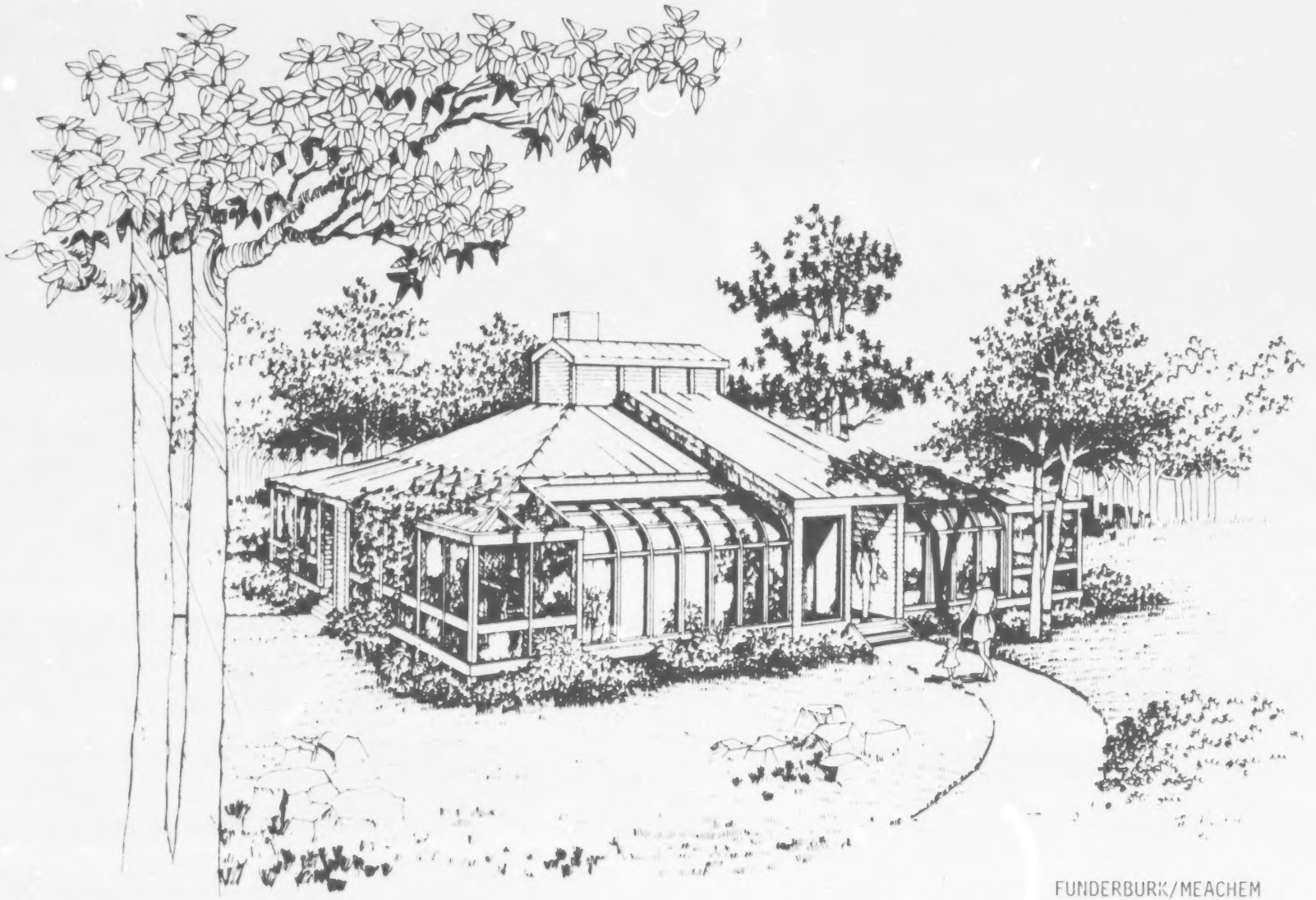
Heating is provided through two south facing greenhouses with energy being stored in a massive floor and central fireplace.

The following illustrations indicate:

PERSPECTIVE - From the south showing the use of porches and vegetation for cross ventilation and shading.

FLOOR PLAN - Show emphasis on exterior porches for outdoor living and sleeping. Notice the use of overhead fans to enhance air movement within the house.

SECTION - Shows the south facing greenhouse for winter heating and high ceilings to vent excess heat and promote air movement in the summer.



FUNDERBURK/MEACHEM
PERSPECTIVE

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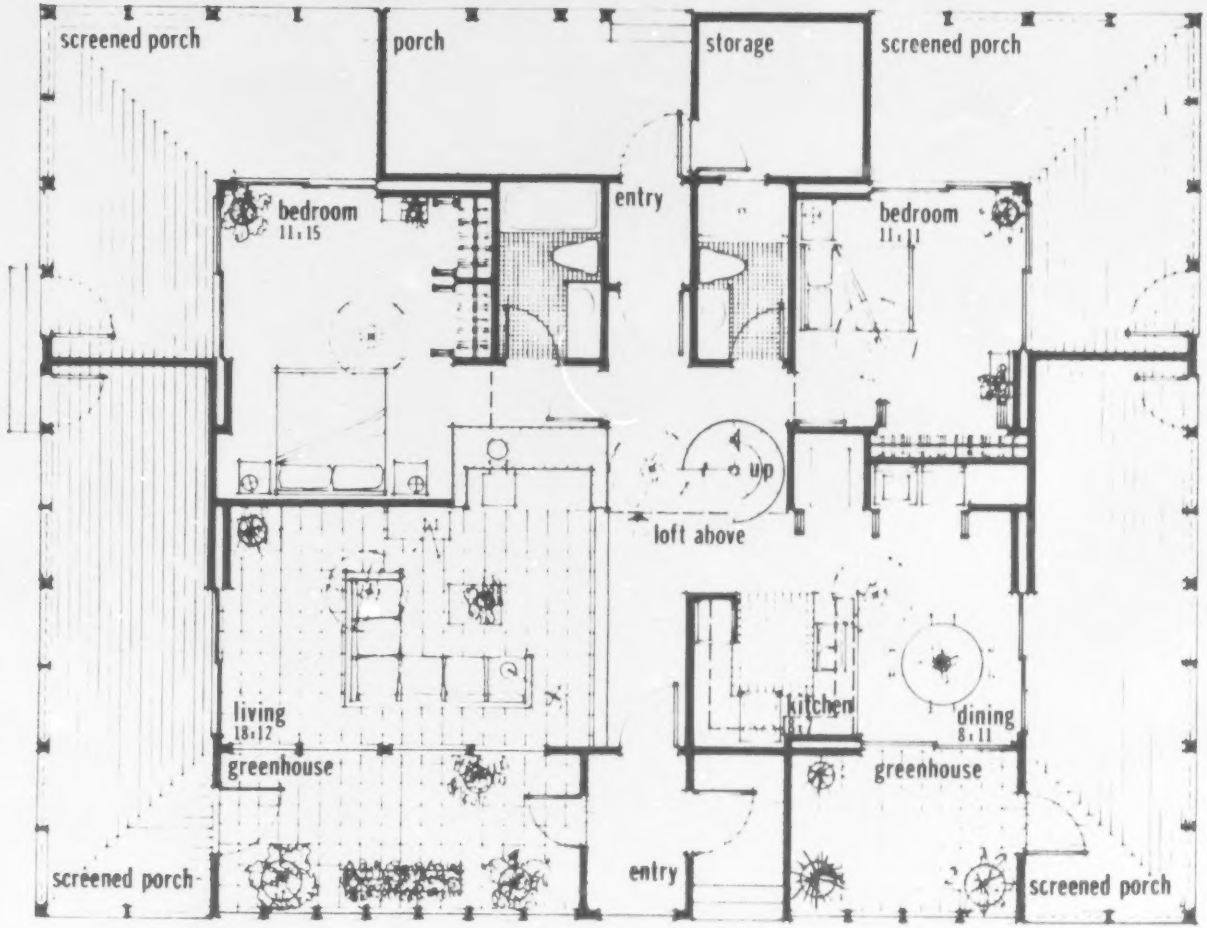

FUNDERBURK/MEACHEM
FIRST FLOOR

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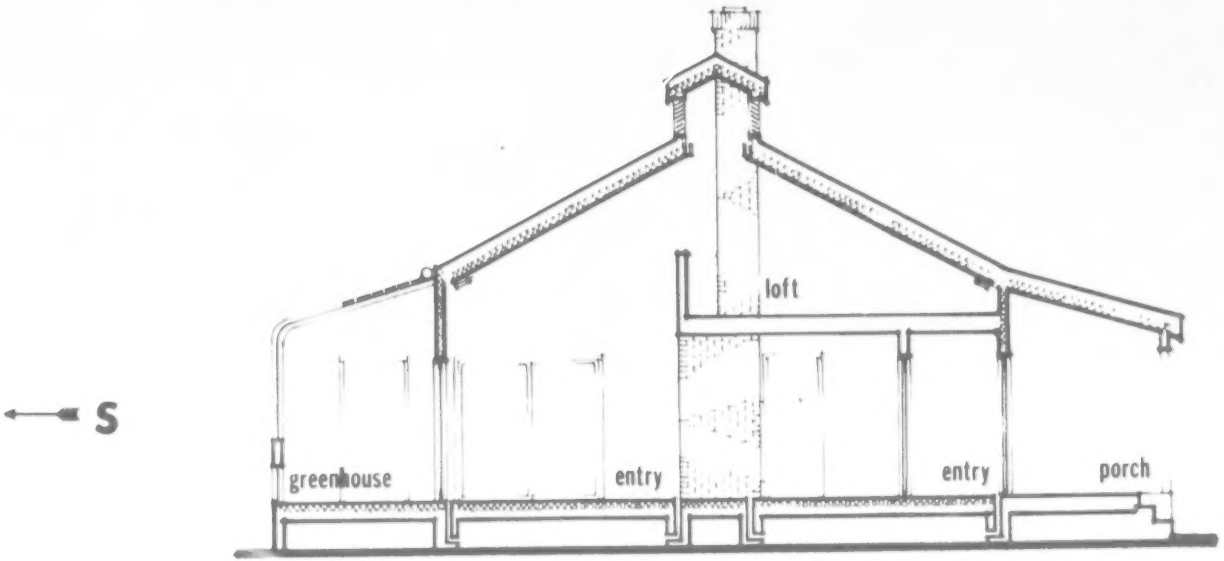

FUNDERBURK/MEACHEM

SECTION

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SECTION 5 HOUSING SELECTION[26]

OBJECTIVE: TO ENABLE THE TEACHER OR STUDENT TO IDENTIFY AND APPLY ENERGY CONSERVATION CRITERIA AND INFORMATION WHEN SELECTING A HOME.

The purchase or rental of a home is a substantial financial commitment which should be carefully and knowledgeably considered by the consumer. Now and in the future, energy consumption should be a major factor in making this decision. Since energy needs and prices vary from area to area, it would be wise for the prospective home owner or renter to request guidelines or tips from the local utility company, board of realtors, or Federal Housing Authority. These sources may provide specific points on "what to look for" in a particular region when evaluating housing.

Whether the consumer is seeking a house, apartment, condominium, or mobile home, several general criteria should be considered: local energy costs; insulation; orientation; windows and doors; heating and cooling system(s); and water heater.

1. Regardless of the type of home, it should be well insulated. Check ceiling and floor insulation by looking in the attic and basement. It is difficult to check wall insulation of a completed structure, but the results of poor insulation can be felt or measured.

2. Consider the orientation. Will the orientation of the windows be beneficial or a problem? In hot climates, the home should be shielded from sun; in cold climates, heat from the winter sun should be utilized (e.g., windows on south face).

3. Check the windows and doors. Are they protected with storm panels? Can they be opened for ventilation? Will the amount of window area place a strain on the heating or cooling system? It is recommended that the window area be no more than 10 percent of the floor area for energy efficiency.[1] For example, a 2000-square-foot home should have no more than 200 square feet of window area. Larger window areas may be used if they are properly planned and installed, for example, with double or triple paned glass.

4. Is the heating and cooling system in good working order? Are the ducts adequately insulated? Most consumers do not have the expertise to answer these questions and should consult a heating or air conditioning contractor. The contractor can determine the proper size and condition of the equipment and estimate costs of repairs if needed.

CAN CONSUMERS CHOOSE ENERGY CONSERVING HOUSING?

Directions: Imagine yourself as each of the following and mark those over which you would have some control regarding energy consumption.

	SITE	ORIENTATION	LANDSCAPING	DESIGN OF a) volume b) foundation c) roof d) structures (walls including building materials, color, and window and door placement
1. A person building a single detatched home(stick-built).				
2. A person selecting a manufactured home to place on a lot.				
3. A person owns a single detached house.				
4. A person renting a multiple attached residence. (You already live there)				
5. A person who is looking for a multiple attached apartment to rent.				

UNIT 5.1 APARTMENTS/CONDOMINIUMS [26]

OBJECTIVE: TO ENABLE THE TEACHER OR STUDENT TO RECOGNIZE THE ENERGY CONSERVATION CRITERIA TO BE CONSIDERED WHEN SELECTING AN APARTMENT OR CONDOMINIUM.

Some energy conservation criteria are unique to apartments and condominiums. Unlike single-family residences, apartments and condominiums are usually in rows or blocks, with several units in a building. This situation affords a good opportunity to save energy, since an apartment or condominium which is adjacent to another apartment or condominium will not be exposed to unheated space on that side; for example, an interior apartment has fewer surfaces exposed than an exterior or end apartment, so it will require less heating or cooling. It can be seen from Figure 52 that Rowhouse 2 has less exposed surface than Rowhouse 1 or 3 because it is bounded on two sides. Apartment B in Figure 52 has even less surface exposed since it is bounded on two sides as well as above and below.

Another aspect of an apartment or condominium which affects the heating and cooling load is the level or floor on which it is located. Due to the fact that heat rises, apartments on upper floors tend to be warmer in the winter than those on lower floors; apartments on the lower level tend to be cooler in the summer. However, if natural ventilation is a major concern, a bottom floor or basement level may have little or no breeze.

Windows and doors in apartments and condominiums are seldom protected with storm panels. This makes the number, size, and orientation of the windows and doors important. For example, an apartment in a cold climate with all its windows facing north will be much more difficult and expensive to heat than one in which the windows face south. Care must also be taken to determine if the apartment will be shaded by other buildings or by vegetation.

Very little can be done to improve the shell of a condominium or apartment, so great care should be taken in its selection. If the apartment or condominium was previously occupied, it would be wise to ask the cost of heating and cooling in previous years. Unusually high consumption (in kwh) could indicate a poorly constructed shell.

Advocate energy conservation to the building owner, manager and other tenants. Recommend added insulation or storm windows and doors if they are needed. Ask for weatherstripping and caulking. Report unnecessary energy waste such as open lobby doors, improperly vented laundry facilities, or heated unused spaces.

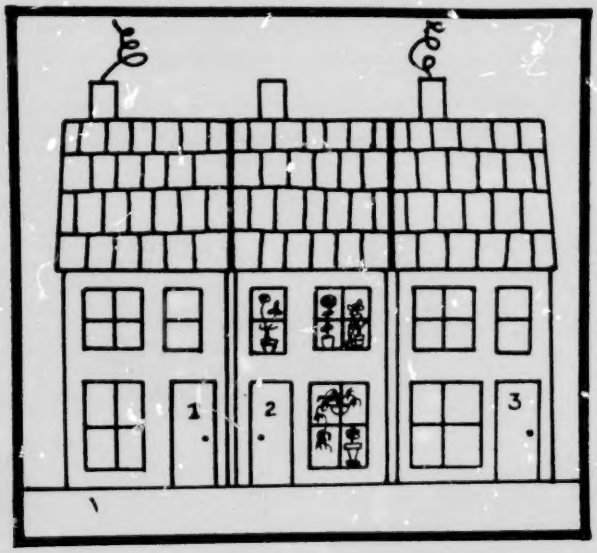
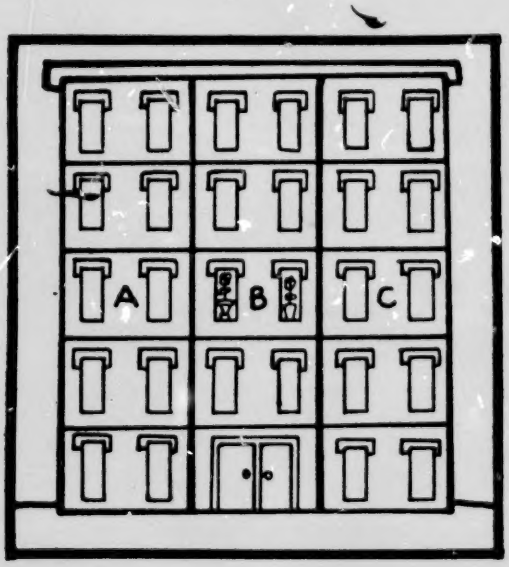


Figure 52

Row Houses (above) and
Apartments (below).



UNIT 5.2 MOBILE HOMES[26]

OBJECTIVE: TO ENABLE THE TEACHER OR STUDENT TO RECOGNIZE THE ENERGY CONSERVATION CRITERIA WHICH MUST BE CONSIDERED WHEN SELECTING A MOBILE HOME.

When you buy a mobile home, check to see if it meets the Mobile Home Construction and Safety Standards established by the U.S. Department of Housing and Urban Development (HUD). If a new mobile home meets the basic HUD requirements for insulation, infiltration, and condensation control, a permanently affixed label of certification should be found on an interior wall. The certification label will give the climate conditions the mobile home is suited for and the capacity of the heating and cooling equipment. Mobile home buyers may also consult the local Mobile Home Association for guidelines in purchasing a mobile home, site selection, and maintenance. Of course, it is wise to seek out the most reputable dealers in an area.

Mobile homes have several common problems related to energy efficiency: thin walls, ceilings, and floors; detachment from the ground; metal exteriors; and elongated, compartmentalized interiors. One of the most cost-effective energy conservation measures for mobile homes is the addition of a skirt or foundation, which encloses the area under the mobile home. Properly installed skirting acts as added insulation. Vents should be provided in the skirting to allow for air circulation, to prevent moisture buildup, and to provide air for the heating system. Also, storm windows and doors may be added, or the installation of 4-to-6-mil plastic sheeting will reduce heat loss and gain. Although it is very difficult to add insulation, rigid foam insulation boards applied to the interior of the home and on the ceiling may be particularly beneficial. [*Caution:* Some rigid foam is very flammable and should not be used; check the insulation manufacturer's specifications.] Also, urethane can be sprayed on the roof for insulation; however, it should be coated with a sealer. Batt insulation can be installed under the floor. The compartmentalized interiors of some mobile homes impede the flow of air and make heating and cooling difficult. On the other hand, the space in most mobile homes is carefully engineered to give maximum usable space within the outside dimensions.

Proper siting of the mobile home on its lot can also reduce energy consumption. In cold climates the long sides should face north and south to take advantage of the winter sun. However, a carport, fence or plantings should be provided on the north side for wind protection. In the warmer climates, the long sides should face east and west to catch the cooling breezes. Storm winds should be avoided. (See Figure 53.)

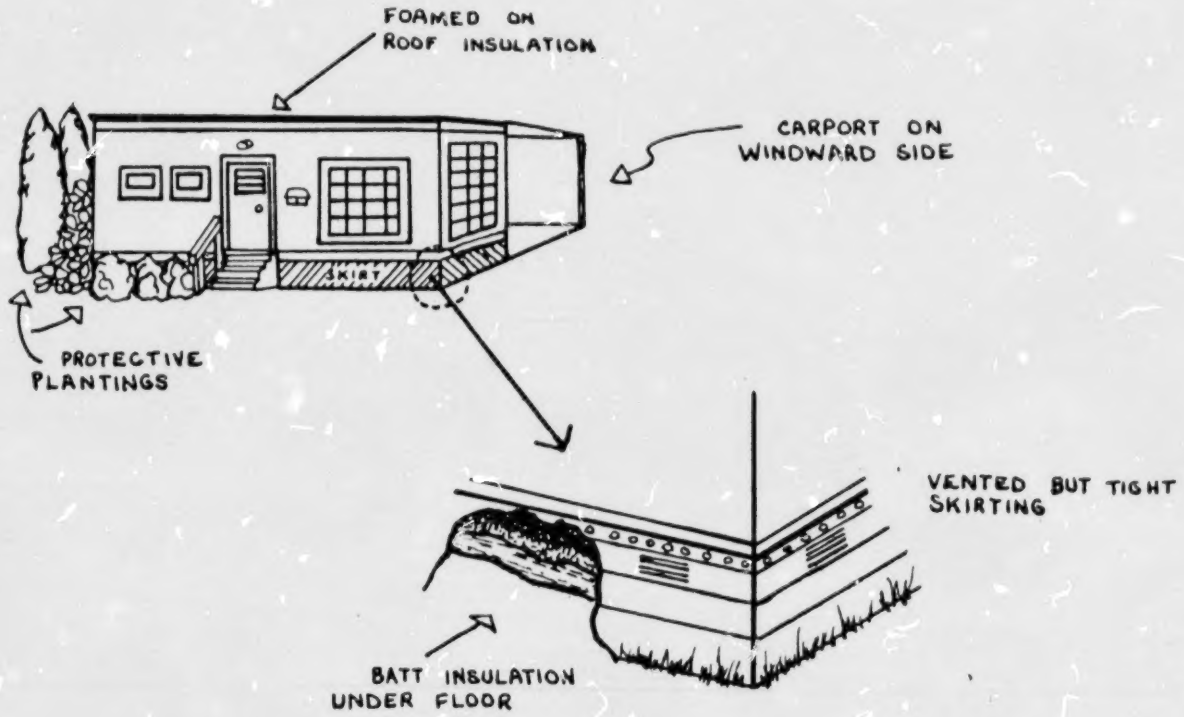


Figure 53. Energy Conserving Mobile Home Features.

UNIT 5.3 OLDER HOMES [26]

OBJECTIVE: TO ENABLE THE TEACHER OR STUDENT TO RECOGNIZE THE ENERGY CONSERVATION CRITERIA WHICH MUST BE CONSIDERED WHEN SELECTING AN OLDER HOME.

Older homes have advantages and disadvantages in relation to energy conservation. First, an older home has a history for heating and cooling which should be obtained from the previous owner or the utility company. These data can tell the potential buyer the heating and cooling cost in previous years (remember to adjust to current rates) and indicate the relative energy efficiency of the home. If the heating or cooling bill is high for the size of the home, one should ask why and how it might be improved. If additional insulation and equipment is needed, an adjustment in purchase price may be warranted. If the ceiling is uninsulated, a small investment in insulation by the new owner can make a large difference in utility costs.

Certain features of older homes may make them energy-inefficient. Very old homes may not have any insulation and inadequate infiltration barriers (e.g., building paper, foil, caulking). The table below shows the R-value for the surfaces of houses as they used to be built and how they can be improved for even a cold climate.

Typical Old House Surface	R-Value	Retrofitted Old House
Roof	3	insulate with 12" fiberglass, R = 43
Wall	4	insulate with 3½" blown insulation, R = 18
Basement	10	insulate walls with 3½" fiberglass or 2" styrofoam, R = 20
Ground floor	5	insulate with 6" fiberglass, R = 25
Door	2	add storm door, R = 3, substitute insulated door, R = 10
Window	1	add storm window, R = 2, add insulating shutters, R = 10

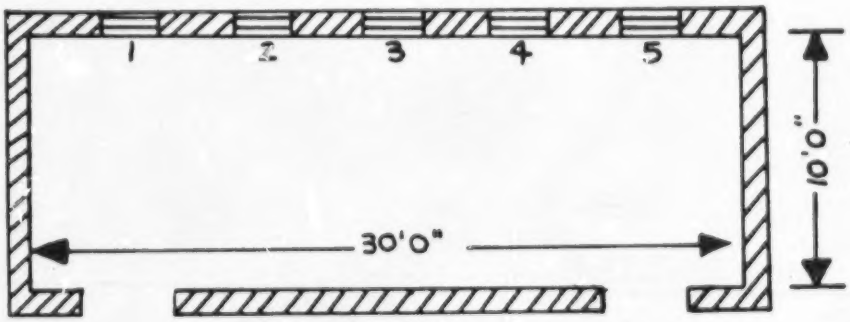
Source: Maine Audubon Society, *Energy Education Project*, Falmouth, Maine.

ACTIVITY D — WINDOW AREA INVESTIGATION[68]

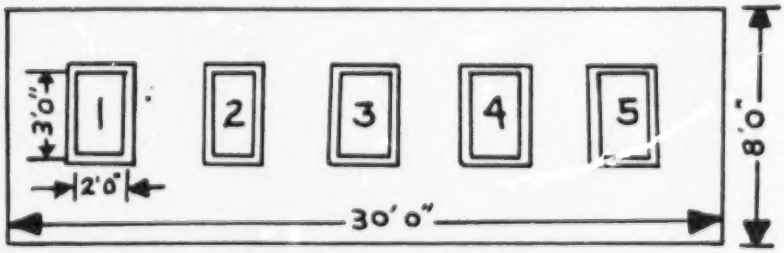
OBJECTIVE: TO DETERMINE THE PERCENTAGE OF SQUARE FOOTAGE OF WINDOW AREA TO TOTAL WALL AREA AND TOTAL FLOOR AREA.

Since glass has much less insulative value than a wall, it is wise to use as little glassed area (windows) as possible to conserve energy for cooling and heating. There are building code restrictions and guidelines for the amount of glassed area: 10 percent of the total square footage of floor-space for the home and less than 20 percent of the total square footage of the exterior wall are generally accepted standards for residences.

It is a simple arithmetic procedure to determine if your home or classroom meets these guidelines. First try the 10-percent-of-the-floor method. In the example below, we see the square footage of the room is 300 square feet.



From the elevation, we see the total *glassed* area is 30 square feet.



To determine the percentage of glassed area you simply divide:

$$\frac{30 \text{ glassed area}}{300 \text{ floor area}} = .10 \text{ or } 10\%$$

Now try the 20-percent-of-total-wall-area method. In the example, the total wall area is 240 sq. ft. since 8' x 30' = 240 sq. ft. The glassed area is 30 sq. ft. Therefore, the percentage of glassed area is:

$$\frac{30}{240} = .125 \text{ or } 12.5\%$$

Using either method, the glassed area is within the guidelines.

Now determine if your classroom or home meets the guidelines.

Method I: 10% of floor area

Total Floor Area_____ sq. ft.
Total Glassed Area_____ sq. ft.

$$\frac{\text{glassed area}}{\text{floor area}} = \_\_\_\_ = \_\_\_\_\%$$

Method II: 20% of wall area

Total Wall Area_____ sq. ft.
Total Glassed Area_____ sq. ft.

$$\frac{\text{glassed area}}{\text{walled area}} = \_\_\_\_ = \_\_\_\_\%$$

Suggestions:

1. Try both methods in the classroom before trying to tackle your home.
2. This makes a good group activity.
3. This Activity may be used in conjunction with reading floorplans and measuring interior spaces.
4. Remember to measure only the *glassed* area of windows--not the frames, too.
5. Note that weather changes will also affect heating and cooling energy uses.

Reducing Infiltration and Exfiltration Through Windows and Doors[18]

Reducing Window Air Infiltration

The quality of windows greatly influences the amount of air infiltration which, overall, is a major heat loss factor. A poor fitting window without weather stripping will allow 5 1/2 times the air infiltration as an average fit window with weather stripping. In terms of energy, the difference is very large 17,800 Btuh for the example home, even with 10 percent glass area. On the other hand, the thermal effect of air infiltration between a poorly fitted but weather-stripped window and an average fit, weather-stripped window is much less but still quite significant—a savings in the example home of 4,000 Btuh.

Storm windows not only reduce heat loss, but they also reduce air infiltration—a savings in the example home of 3,300 Btuh.

So, when using only 10 percent glass area, the addition of storm sash would save 8,800 Btuh, about 60 percent by reducing heat loss through conduction and the other 40 percent due by reducing air infiltration.

In the example home, even one-quarter of an air change per hour for infiltration would be equal to 15 times as much air for four people as is necessary to maintain a satisfactory oxygen level. Further, if the house is extremely tight and no wind persists for a long period of time, odors would build up to the point where people would voluntarily open the windows or doors for short periods long before oxygen depletion would be a problem.

Improving Window Glazing

If the minimum glass area of 10 percent is used, switching from single glazing to either double glazing or storm sash will save about 5,500 Btuh and using double glass and storm sash or triple glazing will save another 2,900 Btuh. Thus, combining reduced area with improved glazing could save 11,500 Btuh by switching from 15 percent single glazing to 10 percent double glazing.

Reducing Heat Gain Through Windows

The area, location, and shading of windows and the use of double glazing or storm sash have an important effect on heat gain loads and air-conditioning.

Window glazing. If it is assumed the example house has 200 square feet on window area (12 1/2 percent of the floor area) and that it is equally distributed on all four sides of the dwelling, the heat gain (at 95 M design conditions and assuming no glass shading by overhangs) is reduced 2,000 Btuh with double glazing or storm windows instead of single glazing.

Window area. If the amount of east and west glass is reduced to 10 percent of the total for each exposure and 40 percent is used in the north wall and 40 percent in the south wall, another 2,100 Btuh can be saved, compared to the preceding example, when double glazing or storm sash is used.

Window shading. Shading southern exposure, glass with an overhang is an method of reducing heat gain in the summer without impairing heat gain in the winter. At the 35-degree latitude (North Carolina, Oklahoma, Las Vegas), a 28-inch overhang will completely shade, in the summer, floor to ceiling glass having a southern exposure and reduce heat gain 50 percent on that glass. With 80 square feet of south-facing double glass, the savings would be 2,100 Btuh.

In high-priced homes where large east or west glass area is essential to the design and shading is not feasible, reflective coated, double-pane glass can cut heat gain as much as 75 percent on east or west glass.

Storm Doors

Assuming the example home has two regular-size exterior doors, the addition of two wood storm doors saves 600 Btuh in winter, and two metal storm doors saves 400 Btuh, just because of the increased insulating value of the storm doors.

Reducing Door Air Infiltration

A well fitted door allows as much air infiltration as a poorly fitted double-hung window, and for wood doors, which warp, this is doubled. Storm doors cut this air infiltration in half. Thus, storm doors will save 1,100 Btuh due to infiltration reduction and will save a total of about 1,700 Btuh or 1,500 Btuh, depending on the type of storm door.

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Roofing[18]

R-value for various roofing materials:

Materials	Description	Resistance (R) For thickness listed
Roofing	Asbestos-cement shingles	0.21
	Asphalt roll roofing	0.15
	Asphalt shingles	0.44
	Built-up roofing 3/8''	0.33
	Slate 1/2''	0.05
	Wood shingles, plain or plastic film faced	0.94

Roof Shingle Color

Even with a well insulated ceiling, the color of the roof does make a difference insofar as heat gain is concerned.

In the example home, a light-colored roof surface compared to a dark-colored roof surface lowers the design load requirement for cooling by 800 Btuh with R-19 ceiling insulation and 450 Btuh with R-38.

Exterior Walls[14]

Framing

Exterior wall framing should be strong and stiff enough to support the vertical loads from floors and roof. Moreover, the walls should be able to resist the lateral loads resulting from winds and, in some areas, from earthquakes. Thus, the top plates should be doubled and overlapped at the wall and bearing partition intersection in order to tie the building together into a strong unit.

Where doors or windows are to be located, provision must be made in the framing to carry the verticle load across the opening. Such provision is made by a header of adequate size, the ends of which may be supported either on studs (or by framing anchors when the span or opening does not exceed 3 feet in widtn).

Defective House Framing

Once a house is a few years old, signs of defective framing can be detected visually. One sign is bulging exterior walls, which are best seen by standing at each corner of the house and looking along the wall. Another method is to make a plumb line out of a key and string and hold it against the wall. If the ridge line sags in the middle, trouble is developing.

Window sills that are not level are a sign of settling, defective framing or original sloppy carpentry. A careful house inspection should include the opening and closing of every window. Sticking windows may be a sign of settling or defective framing.

A sure sign of trouble is a large crack developing on the outside of the house between the chimney and the exterior wall. Other tip-offs to defective framing are cracks running outward at an angle from the upper corners of window and door frames.

Sagging and sloping floors may be detected visually or by putting a marble on the floor and watching to see if it rolls away. This may be a sign of defective framing.

Cracks in the walls other than those discussed above should be a cause of concern but in themselves are not conclusive evidence of framing problems; All houses settle unless built upon solid rock. Rare is the house that does not develop some wall and ceiling cracks. They should be of most concern when accompanied by some of the other signs of defective framing.

Sheathing

Exterior walls should be braced by a suitable sheathing applied horizontally or, preferably, diagonally to the framing.

Wood sheathing is preferred by many builders because it provides a solid nailing base for applying exterior siding and finish. Plywood, makes an excellent sheathing material which can be nailed, stapled or glued to the frame. Other materials used as sheathing include fiberborad and specially fabricated gypsum panels which often have the sheathing paper and exterior finish incorporated into them.

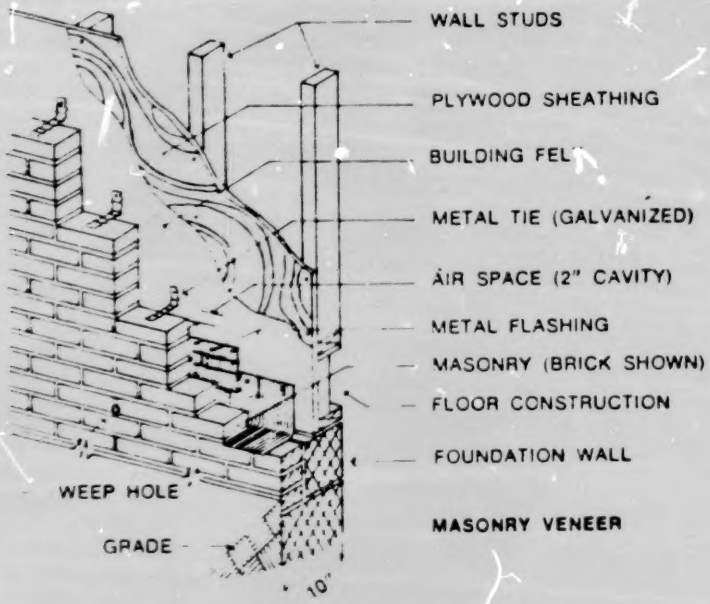
Sheathing Paper

Weathertight walls are provided by covering the sheathing on the outside with sheathing paper which may be either asphalt-saturated felt weighing or any other impregnated paper having equivalent water-repellent properties but which will not act as a vapor barrier. Starting at the bottom of the wall the sheathing paper should be applied by lapping it 4 inches at horizontal joints and 6 inches at vertical joints. Then, strips of sheathing paper about 6 inches wide should be installed behind all exterior trim and around all openings.

Stucco is still popular in dry climates where it can be applied directly to the surface of a solid masonry wall. However, the application of stuuco to a wood frame wall is generally more involved than that of other finishes. Thus, the high cost of labor for its application has reduced its popularity in the northern parts of the country.

When stucco, which is a type of plaster that can be variously patterned or colored, is used, however, its application involves the following steps. First, wood firing strips are nailed to the sheathing through the building paper. Then metal lathing is stretched onto the firing strips. Finally, the stucco is troweled onto the lathing.

A masonry veneer wall is really a frame wall with some variety of masonry siding, most commonly clay bricks, concrete bricks, split blocks or stone. In houses with masonry veneer walls, all of the structural functions of the walls are performed by the framing and not by the one-unit thick masonry which is tied to the frame wall with rustproof metal ties spaced one tie for each 2 square feet of wall. When the walls are constructed, ¾ inch to 1 inch air space is left between the masonry and the sheathing and weep holes are installed at the base to let moisture escape.



Flashing

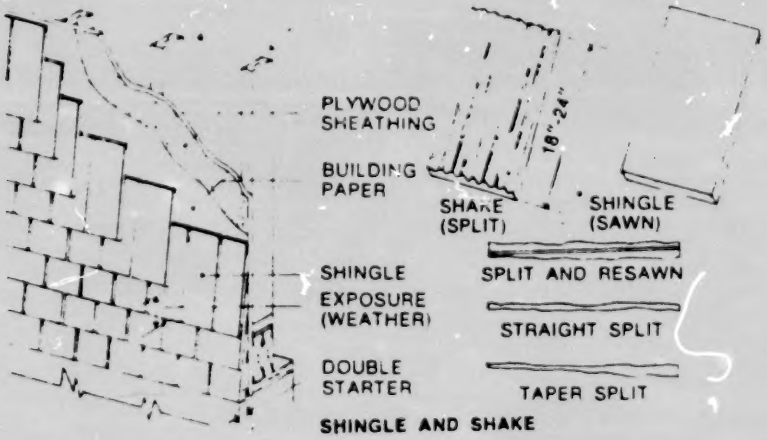
Wherever joints occur in which dissimilar materials come together or wherever there is a possibility of leakage because of the type of construction, it is usually necessary to insert flashing – sheets or membranes of waterproof materials – to turn back the water.

Although flashing may be composed of inpregnated felt or of combinations of felt and metal, it is generally composed of one of the following metals: copper, zinc, lead, leaded copper, tin, galvanized iron or steel, tin-plated steel, soft iron and cooper-bearing or ally steel. Of these, the pure metals are the best. And of the pure metals, copper, lead, zinch and leaded cooper are both the most commonly used and the most effective because they corrode and deteriorate the least upon exposure to the weather. Coated sheets such as galvanized iron and tin-plated steel are satisfactory as long as the coating is unbroken. After that, however, corrosion may be accelerated by the electrolytic action set up between disimilar metals.

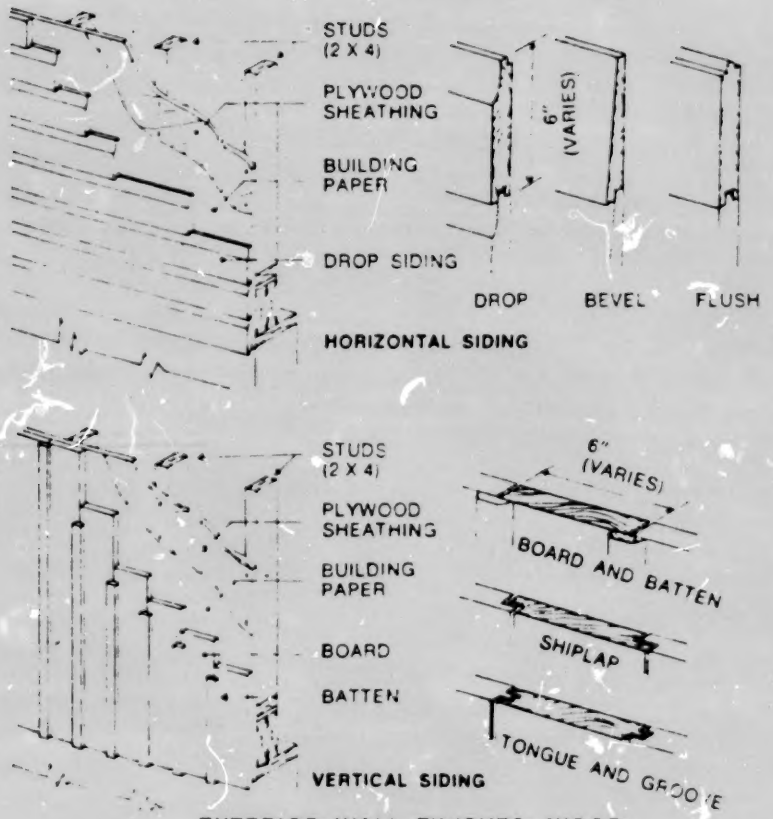
No matter what the metal employed, the installation of flashing is practically identical. Thus, the following discussion, although based upon copper (the metal most widely employed for flashing), is applicable to all of the other metals it is possible to use.

Finishes

Once framing, sheathing and flashing are dealt with, the matter of finishes for the exterior must be considered. Many types of siding and other exterior coverings are applied over wood framing. Often a house has more than one type of siding on it. Numerous patterns of wood siding are available. Names of different types, varying with the locality, include bevel, bungalow, colonial, rustic, shiplap and drop siding.



SHINGLE AND SHAKE



EXTERIOR WALL FINISHES: WOOD

Masonry Walls[14]

Solid Masonry Walls

Solid masonry walls, if well constructed, are very durable and easily maintained. However, they should be insulated and they do require a larger foundation than a wood frame wall. Such walls can be either one or two units thick. Single-unit-thick walls are most commonly made of 8-inch concrete.

While solid multiple-unit masonry walls were, until recently, the most common type of masonry wall, they are now mainly used only where required by local building codes. Where they are used, these walls are constructed either of two layers or brick, tile or cement block or of a combination of materials, with the higher grade on the outside and the cheaper unit at the back-up. In the latter case, masonry headers (bricks laid across two thicknesses of walls) or metal ties are used to tie the face units to the back-up units.

Hollow Masonry Walls

In the case of hollow masonry walls, a cavity masonry wall is built of two units that are separated into an inside and outside wall by between 2 to 4 inches of air space and bonded together with metal ties or joint reinforcement. The exterior wythe (thickness) is usually 4 inches and the interior wythe, 4 to 8 inches.

These cavity walls are used mainly in northern sections of the country for protection against severe outside temperatures and storms. They provide added protection from the elements when insulation is installed in the cavity as well as eliminating the need for furring on the inside wall since moisture pentration is almost impossible if cavity walls are properly constructed with flashing and weep holes (holes at the bottom to let any moisture escape).

Masonry bonded walls are similar to cavity walls except that the two wythes are joined by masonry header courses instead of by metal ties. Although they are economical to construct, their insulation qualities are inferrior to cavity walls and they are, therefore, used mainly in the Southwest.

Parging

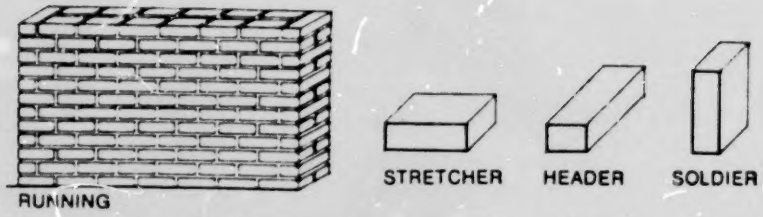
When more than one unit thick of brick or tile is used in the wall, the back of the face brick or tile may be covered with mortar. This parging will substantially increase the waterproofing of the wall. Basement walls are usually parged.

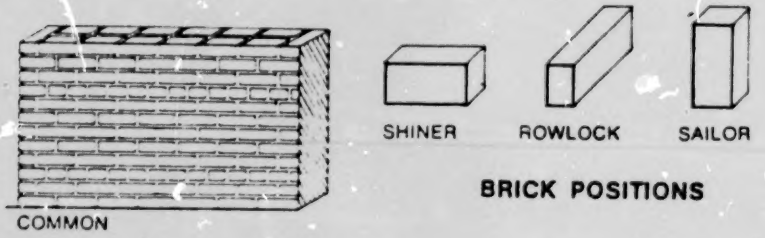
Weep Holes

By inserting short lengths of sash cord through the mortar at the bottom, a weep hole is made through which any water that gets inside a double unit wall may run out.

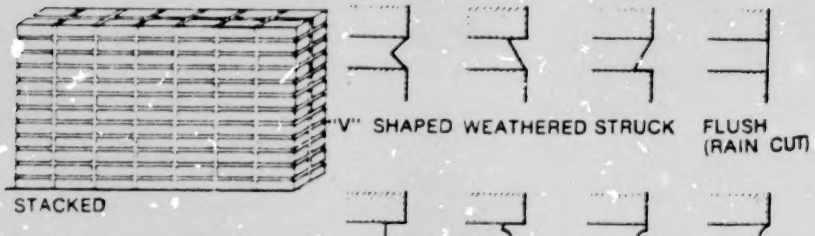
Cleaning

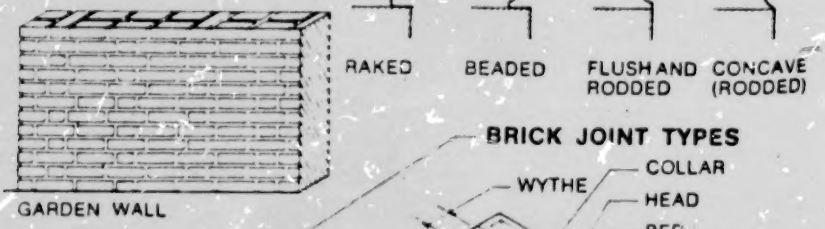
After the wall is completely laid and let stand for 48 hours its surface is cleaned from top to bottom with soap and water. Stains are removed with hydrochloric acid after the wall is seven years days old.



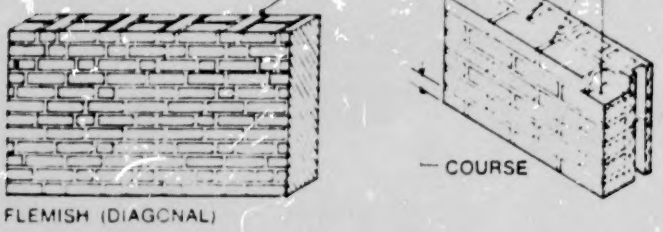


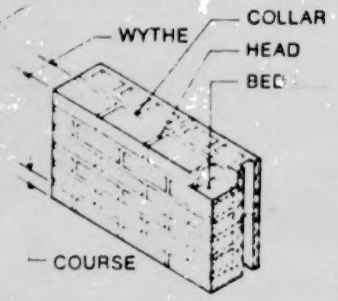
BRICK POSITIONS





BRICK JOINT TYPES





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BRICK BONDS

BRICK JOINTS AND TERMS

UNIT 5.4 NEW HOMES[26]

OBJECTIVE: TO ENABLE THE TEACHER OR STUDENT TO RECOGNIZE THE ENERGY CONSERVATION CRITERIA WHICH MUST BE CONSIDERED WHEN SELECTING A NEW HOME.

New homes are restricted by local building codes and frequently by the FHA-MPS (Federal Housing Authority, Minimum Property Standards). Although these codes require certain construction materials and techniques, the standards are minimal and usually do not afford optimal energy savings, where "optimal" means the minimum cost of buying *plus* operating the house over its lifetime. A prospective home owner or person planning to build a new home should obtain the regional code restrictions. FHA provides checklists and guidelines for builders and homeowners. Of course, it is easier and less expensive to build in energy conservation measures than to add them later. All of the features and practices discussed in Units 3 and 4 should be considered when buying or building a home. Although energy saving features usually tend to increase the purchase cost, the increased mortgage payment will often be more than offset through lower utility bills.

ED. NOTE: A building code is a series of standards and specifications designed to establish minimum safeguards in the erection and construction of building to protect the human beings who live and work in them from fire and other hazards and to establish regulations to further protect the health and safety of the public. Buildings codes can exist under the authority of the State, counties and local municipalities.

Chapter I. Introduction

Solar energy — the energy received by the earth from the sun — has provided, directly or indirectly, almost all the sources of energy for the earth since its creation.

Sunshine consists of a wide variety of electromagnetic waves that are similar in many ways to radio and TV waves. Its three main components are invisible heat waves, visible light rays of various colors, and invisible ultraviolet rays. Most of the ultraviolet portions are absorbed by the earth's atmosphere.

This energy travels from the sun through space at a speed of 300,000 kilometers (186,000 miles) per second, and for practical purposes it is inexhaustible.

For millions of years, sunlight has been captured by photosynthesis in plants. Through the slow action of heat, pressure, and aging, plant substances have turned into coal, petroleum, and natural gas — the fossil fuels which now provide over 95% of the energy used by civilized man.

The human race, and indeed all animal and plant life upon the earth, has always depended for existence on the sun's energy. Most importantly, the sun's rays provide the heat necessary to maintain the temperature required for human, animal, and plant survival. Photosynthesis enables sunlight to provide the energy needed to convert atmospheric carbon into organic forms, which animals use as food, and is a key element in the ecological balance of nature. Solar radiation also produces combustible materials — chiefly wood — that provide heat for cooking and other uses.

The amount of energy reaching the earth's surface is so vast as to be almost incomprehensible. Two examples may make this clear. On a global scale, the solar energy that arrives in 1 - 2 weeks is equivalent to the fossil energy stored in all the earth's known reserves of coal, oil, and natural gas. In the United States, the solar energy that reaches $\frac{1}{500}$th of the country — an area smaller than that of Massachusetts — could, if converted at 20% efficiency, satisfy all our present needs for electric power.

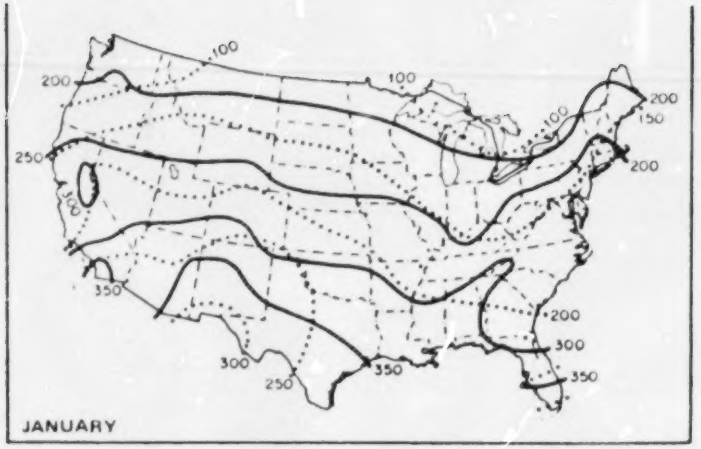
But there are two disadvantages of solar energy. One is that the sun's energy is diffuse, i.e., it is spread out very thinly. It must therefore be collected by some means because only a small amount arrives at one place. The second problem is that it is *intermittent*. The sun shines only by day and is often obscured by clouds. Thus its energy must be *stored* until it is needed.

Sunlight arriving at the edge of the earth's outer atmosphere carries energy at an approximately constant rate of 1.36 kilowatts per square meter (130 watts per square foot) of area covered. In terms of heat, this is equivalent to 428 British thermal units (Btu) per square foot per hour. (One Btu will raise 1 pound of water 1°F.)

Measurements in various locations all over the U. S. have shown that, on the average, over an entire year (including night and day, winter and summer, cloudy and clear conditions) about 13% of the sun's original energy arrives at ground level. (The actual amount at any particular spot at any given moment ranges from much higher to much lower than this average value. See Figure 2.) This average is equivalent to about 177 watts per square meter (16.4 watts or 58.5 Btu per square foot) per hour.

If arrangements can be made to collect even this diffuse energy over a relatively large area, tremendous quantities can be made available. For example, the average rate at which solar energy falls on just 0.4 hectare (1 acre) is equivalent to about 710 kilowatts (950 horsepower).

To deal with the other basic problem — the intermittent characteristic of solar energy at ground level — inexpensive techniques are required to store large quantities of energy. The cost of storage is usually a significant fraction of the cost of operating a solar energy installation. Thus major efforts are under way in energy storage research and development.



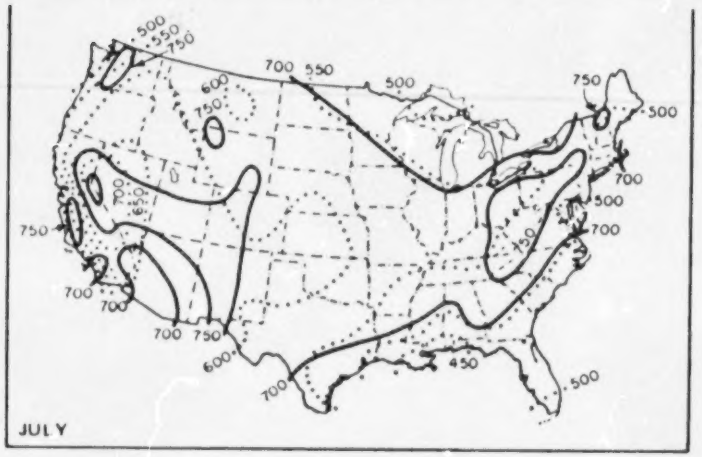


Figure 2 *Lines of equal total daily solar energy at the ground on cloudless days (solid lines) and on days of average cloudiness (dotted lines) in January and July. Units are calories per square centimeter per day. The annual average for the United States is 377, corresponding to 13% of the original energy of the sun. Expressed in American units, this is 58 Btu per square foot per hour.*

Of course, mankind has used solar energy for thousands of years. The winds, produced by unequal amounts of solar energy falling in different geographical locations, have been an important tool since earliest recorded history.

Winds that moved ships around the globe were the main source of energy for transportation for many centuries. Windmills are also an ancient way of harnessing solar energy. Even though windmills in many parts of the world have given way slowly to other kinds of energy sources, there is considerable interest now in reviving them as a supplementary source of energy; this is covered in more detail in Chapter III.

The sun's energy has also been used extensively by man simply as heat for a wide variety of applications. These are covered in Chapter II. The use of solar energy to generate electricity is outlined in Chapter III, while Chapter IV describes the possibilities of using solar energy to produce high quality fuels.

All these solar energy applications have a number of advantages in common: sunlight is inexhaustible compared with almost all other known available energy sources; it is constant as it arrives in the vicinity of the earth, even if the amount reaching the ground varies; and it is clean. The only environmental impact of significance to initial applications is aesthetic, i.e., there is a need to design solar energy facilities so that they are attractive.

One other advantage of solar energy is that the cost of the "fuel"—the rays of the sun—is zero. But that is counterbalanced by the initial cost of installing the equipment. Thus, for example, a homeowner using solar energy for heating will save on his bills for oil, gas, coal, or electricity. But this saving may be more than counterbalanced by the payments on the bank loan needed to pay for the installation of the solar heating plant. Nevertheless, the energy is there and, in a time of national and world energy supply problems, the United States has undertaken programs to harness it.

The purpose of this booklet is to present some basic information about the various applications of solar energy and the developments in technology that will be needed to use it more effectively for the benefit of mankind. Since our supplies of oil and natural gas are being rapidly depleted, it is

UNIT 4.6 SOLAR TECHNOLOGY [26]

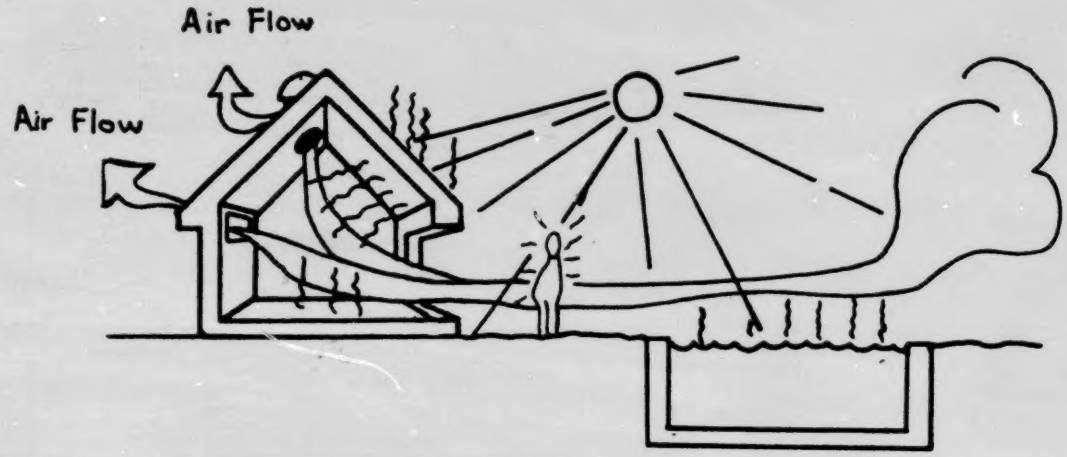
OBJECTIVE: TO ENABLE THE TEACHER OR STUDENT TO RECOGNIZE THAT SOLAR TECHNOLOGY CAN BE USED FOR RESIDENTIAL HEATING, COOLING, AND WATER HEATING.

The objective of solar technology is to use the energy of the sun to reduce the need for the use of other, more scarce, fuels. Solar energy may be used to heat space, cool space, heat water, and generate electricity. However, at this time, it is not economically feasible to use solar energy for all of these tasks in homes throughout the United States. Solar energy is most economical in areas which have high energy costs, scarce fuel supplies, severe climatic conditions, and generous quantities of sunlight.

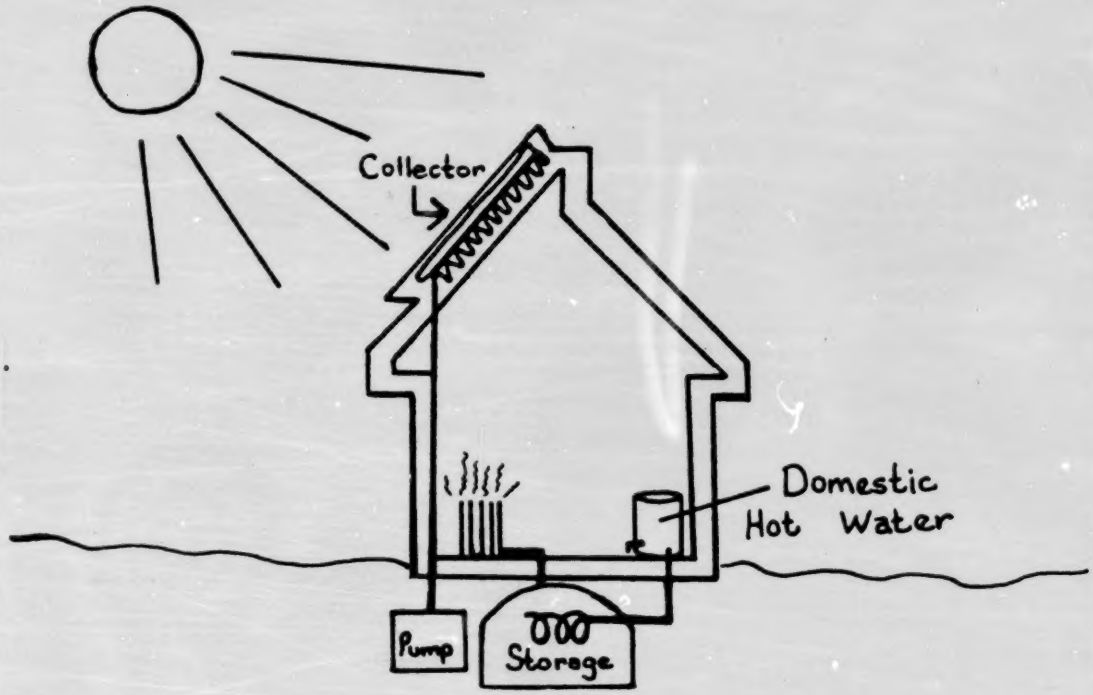
The sun's energy may be used by *passive means*, with no additional energy, or *active means*, where additional energy such as electric fans or water pumps or electric heat pumps are used to transfer the sun's thermal energy.[40] In the previous units, a number of passive means were presented for collecting solar energy; for example, placing the majority of a home's windows on the south side to trap the winter sun. However, passive means are most valuable in sunny regions, since the sun's energy cannot be collected when or where the sun doesn't shine. (See Figure 51.) The sun's heat can also be used passively to create ventilation through the house. This was described in UNIT 4.1. Or the sun's thermal energy can be used to directly heat water for domestic use. The trouble with passive is that you may not be able to get the energy when you need it or where you need it, and it is very difficult to store for long periods.

In an active solar house, many of these problems can be overcome by using collector, transport, and storage systems. The collector absorbs the sun's energy; then a fluid or air is used to transport the thermal energy to where it is needed, or to storage. Additional energy may be needed to move the thermal energy to where it is needed. A heat pump may be used to draw the thermal energy from storage and to provide supplemental heat when the sun's energy is not adequate. (See Figure 51.) A variety of collectors are now on the market which may be built into new houses or added to existing houses.

Before selecting, purchasing, or installing a solar system, you need to investigate it thoroughly. The Federal Energy Administration and Office of Consumer Affairs have developed a buyers guide, *Buying Solar*. Also, you may obtain additional information from The National Solar Heating and Cooling Information Center by writing to Solar Heating, P.O. Box 1607, Rockville, Md. 20850, or by calling (toll free) 800/523-2929 or in Pennsylvania 800/462-4983.



PASSIVE



ACTIVE

Figure 51. Passive and Active Solar Systems.

SOLAR RESEARCH HOMES [3]

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COLLEGE OF AGRICULTURAL SCIENCES
AND
USDA-SEA, RURAL HOUSING RESEARCH UNIT
COOPERATING

FUNDED BY APPALACHIAN REGIONAL COMMISSION
AND
SOUTH CAROLINA AGRICULTURAL EXPERIMENT STATION

CONSTRUCTED BY AZTEC SOLAR HOMES, INC., IVA, S. C.

Solar Greenhouse Residence (GHR)

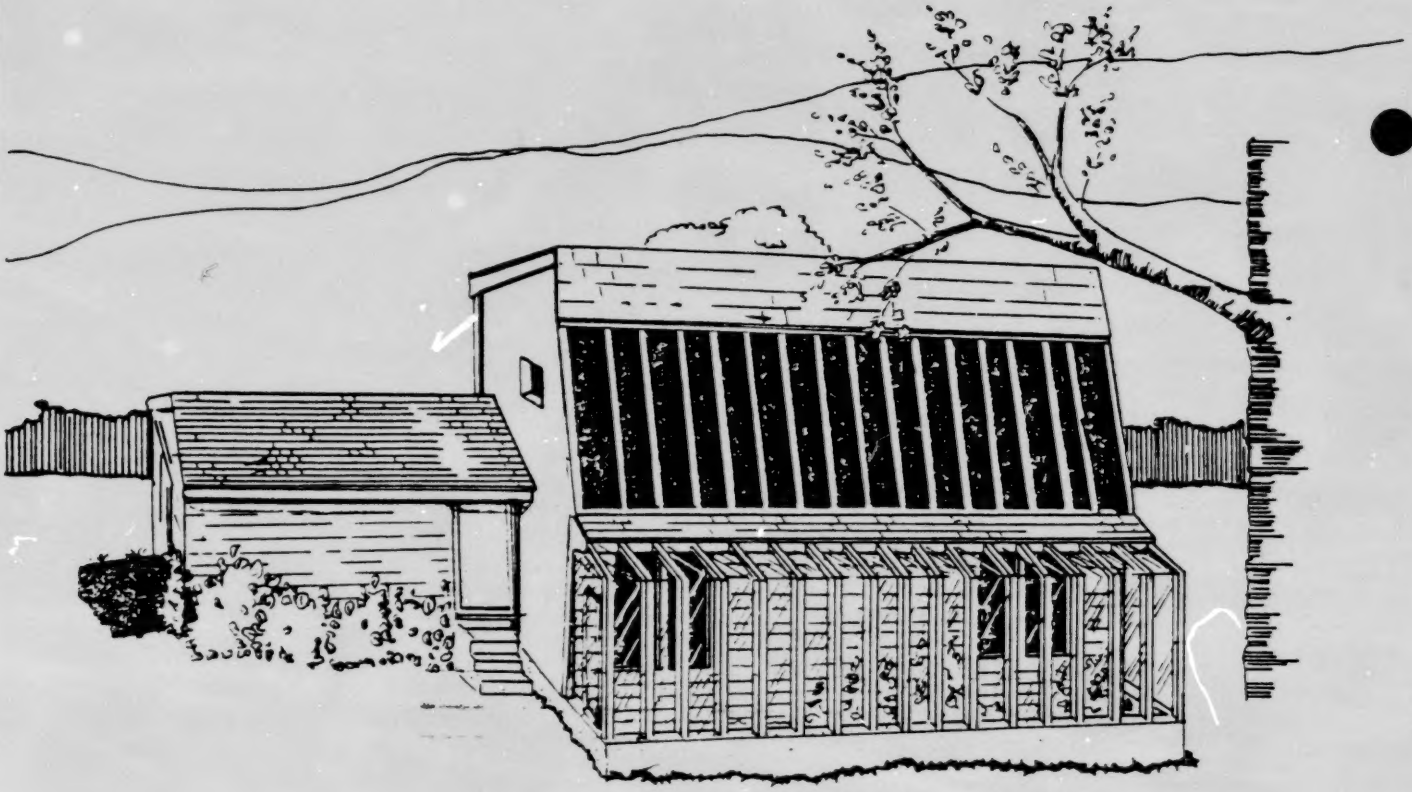
A greenhouse and solar heated residence have been combined to form an energy efficient facility having the added capability of year-round food production. The greenhouse produces heat equal in quantity to that used and requires no extra cost above initial construction costs, thus demonstrating the highly compatible and complimentary aspects of the two units. It is estimated that the facility could save the occupants approximately $430 in food costs and $410 fuel costs annually at 1978 prices.

Solar Earth Insulated House (EIH)

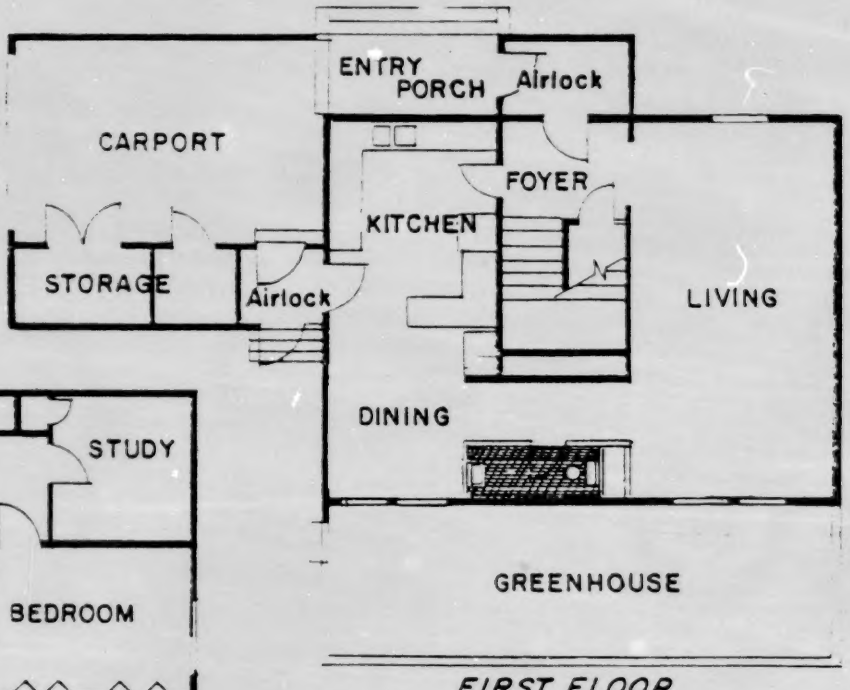
A solar heated residence is partially embanked in the earth, thus increasing the interface with the relatively constant subterranean environment and decreasing the interface with the highly variable atmospheric environment. Heat losses and gains are thereby minimized reducing the required capacities of the respective heating and cooling systems. A conventional exposed roof is utilized at much less cost than would be required were the house actually underground. Waste heat can be rejected to gravel along the embanked perimeter to further reduce heat losses. Construction consists of treated wood walls supported by crushed stone footings.

Statistics

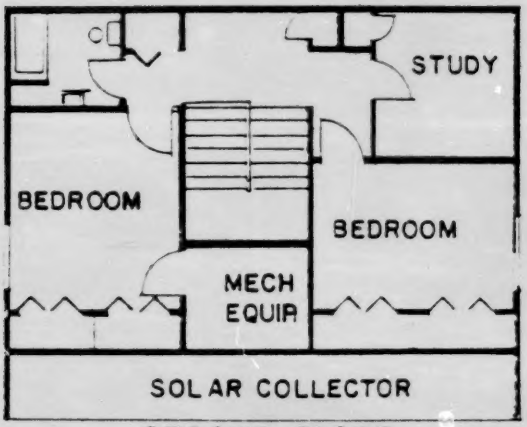
	GHR	EIH
Heated Floor Space (sq. ft.)	1472	1080
Greenhouse Space (sq. ft.)	248	--
Collector Space (sq. ft.)	384	412
Collector Type	Flat Plate, Air	Flat Plate, Air
Collector Slope (Degrees)	60	49.4
Storage Media	rock	rock
Storage Volume (cu. yds.)	50	12
Primary Heating	solar	solar
Back-up Heating	electrical	electrical
Primary Cooling	natural	none
Back-up Cooling	2.5 ton A.C.	none
Greenhouse Cooling	evaporative cooler	----



SOLAR RESEARCH HOUSE
GREENHOUSE RESIDENCE

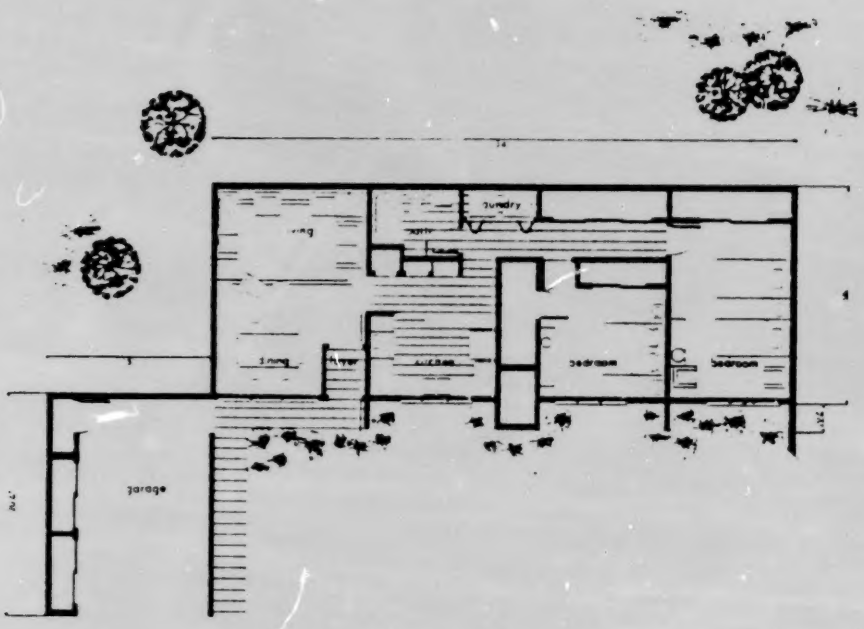


FIRST FLOOR



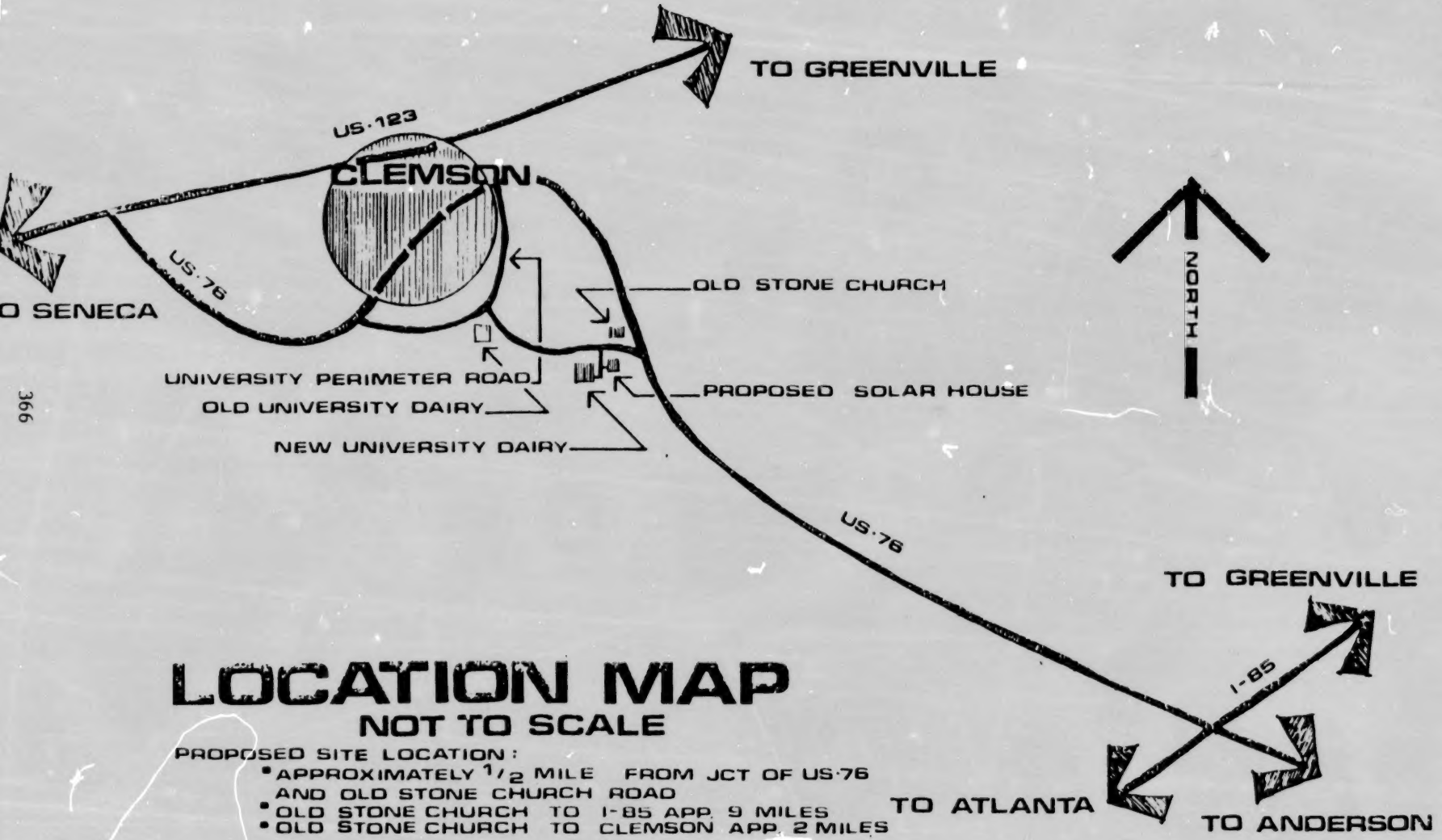
SECOND FLOOR

CLEMSON UNIVERSITY
COLLEGE OF AGRICULTURAL SCIENCES
USDA – SEA
RURAL HOUSING RESEARCH UNIT
CO OPERATING



FLOOR PLAN

312 PERSPECTIVE



LOCATION MAP

NOT TO SCALE

PROPOSED SITE LOCATION:

- APPROXIMATELY 1/2 MILE FROM JCT OF US·76 AND OLD STONE CHURCH ROAD
- OLD STONE CHURCH TO I-85 APP. 9 MILES
- OLD STONE CHURCH TO CLEMSON APP. 2 MILES

366

313

311

OUTLINE OF FACTS ABOUT ENERGY SOURCES

A. Coal

Large reserves – 100 to 200 years' supply at current energy use rate

Conversion to electricity is current practice

Can be converted to a gas or oil product but considerable development necessary

Strip mining, water pollution and air pollution pose environmental hazards

Expensive land reclamation

High water usage in electrical generation and conversion to gas and oil

B. Nuclear Fission (Conventional)

Short supply of U^{235} – 30 years

Conversion to electricity is current practice

Electricity costs are competitive

Radioactive wastes are major environmental problem

New development are needed

C. Nuclear Fission (Breeder)

Greatly increased fuel supply – natural uranium is 99.3% U^{238} and 0.7% U^{235}. Also thorium is a source of fuel

High development costs since technology is not well established – $10 billion?

Plutonium is very toxic

D. Nuclear Fusion

Nearly inexhaustible supply of deuterium in water – 700 gal/1,000 gal. Lithium could be limiting but no real problem

Nuclear wastes are a minor problem

Temperature of reaction 100,000,000 ^{o}C – containment problem has not been solved

Scientific concepts and technology not known

Distant future

E. Solar Heating and Cooling

Good potential for new residential and commerical buildings - perhaps can satisfy one-half of the needs by year 2000

Expensive equipment - previous estimates of $\$4\text{-}6/ft^2$ now revised to $\$10\text{-}12/ft^2$

Usually need storage capacity and back-up system

Limited life of collector system

F. Solar Thermal Conversion

Concentrate solar energy in collector to produce high temperatures

Can use conventional electricity generation systems once energy collected

Sun is intermittent source so need an expensive storage system

Large equipment investments

Aesthetics are a problem

G. Bioconversion

Low percentage of solar energy is converted to a usuable form

Electricity as a by-product of solid waste recycle systems is an importance source

H. Oil Shale & Tar Sands

Large reserves available but net energy produced may be small

Environmental problems are significant particularly with shale

Processing consumes large quantities of water

Costly process: 50,000 bbl/day - $500,000,000

I. Geothermal

Large source of energy but only available in limited locations

Low efficiencies due to low temperatures of water systems

Difficult equipment problems due to scaling and corrosion

Environmental problems due to thermal pollution, escaped gases, salts

Promising process energy source

Can be used to generate electricity

J. Wind

Many windmills to obtain reasonable quantity of energy

Few favorable sites but potential use in remote areas

Variable nature

K. Ocean Tides

Highest tides at the highest latitudes, but this is not where the energy is needed

Salt water corrosion is a major problem

High cost

Can be used to generate electricity

SOFT ENERGY PATHS[16]

''I urge everyone to take a look at Soft Energy Paths. Lovings is one of the wisest of those in the alternative enrgy field, he understands that there are always political implications inherent in technology, and his wisdom ought not be allowed to be buried under the current pro-nuclear avalanche.'' - Kirkpatrick Sale, Politicks

''Amory Lovins is the real thing: an anti-nuclear polemicist whose arguments are so well organized, clearly expressed and extensively documented that even the most enthusiastic partisans on the other side will have to take notice.....His Contribution both enlivens and deepens the Great Energy Debate.'' - New York Times Book Review

''The main reason for Lovin's importance is that he has managed to redefine the energy problem, and thereby to change the frame of reference of a large number of technical debates. He has first-rate credentials as a nuclear physicist and, in his words, a former high technologist. He is familiar with a staggering body of recent literature on energy. He writes clearly and often eloquently. All of these things help, but his appeal is that he has managed to define a pattern against which a jumble of technical choices can be compared and evaluated.'' - Fred D. Baldwin, The Nation

''Soft Energy Paths could become for the energy community what The Limits to Growth was for environmentalists.'' - New Scientist

Foreward

Whether we are talking of an individual citizen or of a whole community, ''cataclysmic wealth'' can have disastrous consequences. One thinks of all the sad accounts of the miseries that decend on sudden winners of sweepstakes and lotteries - or even of the later years of Howerd Hughes. On a grander scale, the golden flood from the conquered Aztec and Inca Empires destroyed the balance and sanity of the Spanish state. However valuable a sustained increase in resources may be, it is nearly always a disaster for the shower of gold to arrive in a cloudbust.

Can the disasters be avoided? The question is urgent, for Western society has just been through such a cloudburst - the ''black gold'' of oil at fifteen cents per barrel at the wellhead - and must now cope with the consequences which, by most historical analogies, can be disastrous. The timeliness of Mr. Amory Lovin's book lies in its direct confrontation of this crisis, its great value in the calm good sense and solid practical value of the alternatives he offers to catastrophe.

There is no secret about the nature of the temptations offered by sudden vast wealth. Its use rises sharply to create new habits and expectations. These habits are accompanied by an irrational lack of care about usefulness or waste. The process develops habits in individual people, and institutions in whole

From Soft Energy Paths: Toward a Durable Peace, Copyright 1977, Friends of Earth. Copyright with permission from Ballinger Publishing Company.

societies, which accustom them to operating on the basis of excess and wastefulness; and, although different episodes have different endings, one prospect sees the affected groups, long after the cloudburst of wealth has passed, trying every kind of expedient – borrowing, sponging, speculating – to try to ensure that the provate habits or public institutions of excess and waste are maintained. The result is at best a measure of social disintegration; at worst, collapse.

In the past twenty years, industrialized societies have in varying degrees displayed most of these symptoms. In the 1960s, energy comsumption in general grew on average by 5 to 6 percent each year – in Japan by a remarkable 12 percent – with oil's share in commercial energy supplies growing from 39 percent in 1960 to 51 percent in 1974. Owing in part to steadily declining real costs, the growth of demand for electricity was even more rapid – over 7 percent a year between 1958 and 1972 – and this in spite of the fact that around three-quarters of the energy used to build and run most power stations is lost in producing and distributing the electricity, a loss that is often not recouped by correspondingly efficient use of the electricity. Private cars, running on cheap gasoline, have risen in number from eighty-nine million in 1960 to around 214 million in 1975. They in turn have displayed less energy-intensive forms of public transport, spread urban settlements thinly over the countryside, and thus imposed the need for futher cars.

These new urban patterns have been one factor in creating a rising demand for energy in food production. They entail a very wide network for moving, packaging, freezing, distributing, and finally selling, storing, and cooking food. As a result, most of the energy used is expended after the food leaves the farm. In the U.S. in 1970, only a quarter of the energy used in the food system was consumed on the farm. Yet high merchanization and the overuse of artificial fertilizers, pesticides, and herbicides have ensured that the farms, too, steadily increase their energy demand – not least because urbanization itself tends to displace farming onto less fertile land.

This mixed pattern of rising use and rising waste has had its customary effect. Both people and societies tend to think it normal and believe that the trend should continue. That a nation's wealth and its energy use are virtually two ways of saying the same thing in a example of the kind of folk myth created by sudden affluence. The fact that North Americans use nearly twice as much energy as the not exactly impoverished West Germans – and they, in turn, about twice as much as the far from destitute New Zealanders – is insufficiently known to weaken the fable. Thus all the elements of the customary response to continue, deep belief that the only acceptable way is more of the same and even more of more.

Then comes the crisis. Cheap, accessible supplies of oil and gas are running down. Most sources of new supply – North Sea oil, the Alaskan North Slope – are inherently more expensive to exploit, expensive not only in money but in other and deeper ways. There is a desperate search for means of continuing the old abundance. Although obvious possibilities such as coal have much larger reserves, the means of transforming them into the needed liquid or gaseous fuels are once again, comparatively expensive and unpleasant. Yet an economy in which the all-pervasive energy patterns of recent affluence can only be achieved at much higher prices suffers precisely the kind of pressure that sends the pursuers of vanishing wealth off in ever more extreme directions. And there, as they look, stand the temptations of the nuclear economy in which plutonium in fast breeders, or, later, tritium and deuterium in fusion reactors will allow – such is the belief – the "Great Energy Jag" to continue.

Like addicts in general, they wave aside the risks. Fusion may still be technically doubtful and carries with it alarming implications of centralized power. It is also not free from problems of radioactive wastes. The even more lethal fission wastes that must follow from a general expansion of uranium-, then plutonium-fueled electricity generation are cumulative since their decay to relatively safe levels takes thousands upon thousands of years and all the time new supplies will be coming into the disposal system. As the use of plutonium and the stores of waste increase, so does the possibility that, by theft or terrorism, society will be blackmailed and attacked. Behind the whole nuclear venture stands the appalling possibility of nuclear war - possibly the ''final solution'' itself. No matter. As in the case of alcoholics warned of self-destruction, these possibilities are ignored or denied. The energy addiction is too strong, the alternatives not apparent. Are we distined to repeat the full cycle of cataclysmic wealth, with disaster as the last chaper? Worse still, are we, owing to the deadly nature of the nuclear choice, likely to ensure that our common collapse will be the last?

This is the profound seriousness of the issues that are faced in this book. Mr. Lovins does not in any way underplay the risks. On the contrary, he gives them the stability and certainly of scientific fact. But it is nonetheless a hopeful study, for he shows how pitifully mistaken our energy ''alcoholics'' are in supposing that no alternatives exist. There are alternatives on every side, and all of them, whether they turn on sane conservation or on the use of safe ''energy income,'' add up to a life quite as convenient as our present existence, certainly more sustainable, and arguably more profoundly satisfying in human terms.

We can cut our waste with such simple measures as returning bottles or building houses that do not leak heat like sieves. We can design city layouts with appropriately sized power stations - as in many Swedish communities - where spare heat from electricity generation warms the houses and heats the water. Industry can provide a much larger share of its own power, and even export a surplus, by ''cogeneration'' (electricity generated as a byproduct of the process heat normally produced). We can use electricity, with its high cost and potential wastefulness, only for the tasks that genuinely require it - lighting, electronics, electrolysis, motors in industry and home appliances and railways - which together represent less than a tenth of all our end-use energy needs. Heating a house to 68°F with electricity from a nuclear reactor in which fission at trillions of degrees heats the fuel to thousands of degrees is a gratuitous absurdity; and in England, for example, over half our end-use needs are for such low grade purposes as low temperature heat. Much simplier, cheaper, and surer technologies that better match the end uses - space heating, cooking, mobility - are available. Most uses simply do not require the energies needed to produce atomic fireballs. A single nuclear reactor, meticulously engineered, carefully tested, and thoughtfully sited a safe 150 million kilometers away - in fact, the sun itself - is quite enough.

In the place of the hard and unforgiving technologies of nuclear power (coupled with massive and environmentally disruptive growth in fosil fuel consumption), Mr. Lovins proposes a phased, orderly transition to the ''soft technologies'' based on ''energy income.'' They include using direct solar energy, wind, and biomass conversion - the use of crop, wood, and other organic wastes and, where suitable, perhaps also an ecologically balanced growth of trees and shrubs for conversion to liquid and gaseous fuels. These diverse means can be deployed within half a century to meet the needs of a society that at

at the same is using existing systems as a bridge to the future, carrying through all the necessary means of careful resource conservation, suiting its types of energy to the nature of their end use, and learning all over again that the words ''thrify'' and ''thrive'' have a common root.

In short, we do not have to end our recent cataclysmic burst of energy wealth in equally cataclysmic disaster. Mr. Lovin's study, based in the main on American evidence for specificity, proves that the means for a less wasteful, more rational, and more humane future are not only available: they are cheaper and less difficult than the plutonium economy. If other nations were to undertake the same range of review and enquiry, they would be forced to the same conclusions. But they must do their own studies, for the great diversity of energy problems in the world calls for an equal diversity of solutions. In many countries such as India and China, village-scale biogas plants can provide the driving force for rural development. In Brazil, starchy crops such as cassava can and will be used to make vast amounts of fuel alcohols while in Finland and Quebec the same can be done with forestry residues. Wind machines are well suited to Denmark, solar furnaces to Saudi Arabia. Existing large hydroelectric dams can be complemented by new (or resuscitated old) small local hydro sets in Thailand as in New Hampshire. Solar heat in Mexico or Australia needs different technologies than solar heat in Scotland or Sweden, but all are practicable. The concepts behind the integrated food-water-energy systems that work so well in East Asia are being successfully adapted to maritime Canada and will be needed in England.

No two countries, no two parts of the same country, have the same energy needs or opportunities or should seek the same mix of energy technologies. No single book can offer a universal prescription. But it appears, as the exciting search for appropriate answers gain speed, that each country and each person, in different ways, can achieve the same goal: capturing enough of the sun's bounty to give mankind the chance of living - perhaps even happily - ever after.

The conceptual basis for that general conclusion, which national studies can refine and implement in their own diverse ways, is what this book provides. It is the great merit of Mr. Lovins's work that he can convince both the citizen and the scientist that, beyond the great energy outburst, survival is not only possible: it may well be more safe and agreeable as well. This is a conviction that no government, and no voter, can afford to overlook.

- BARBARA WARD

Lodsworth, Sussex
4 March 1977

BIBLIOGRAPHY

1. Adams, Anthony. *Your Energy Efficient House.* Charlotte, Vermont: Garden Way Publishing Co., 1975

2. Christie, Leo and Pestle, Ruth. "Voluntary Simplicity of Lifestyle." *Tips and Topics in Home Economics.* Lubbock, Texas: Texas Tech University, 1981.

3. College of Agriculture Sciences. *Solar Research Homes.* Clemson, S.C.: Clemson University, 1982.

4. Cooperative Extension Service. "Controlling Internal Moisture Problems in the Home." *Engineering and Technology Guide.* Clemson, S.C.: Clemson University, 1975.

5. Cooperative Extension Service. *Energy News.* Clemson, S.C.: Clemson University, 1978.

6. Cooperative Extension Service. "Fuel Savings." *Home Energy Guide.* Clemson, S.C.: Clemson University, 1977.

7. Cooperative Extension Service. "Weather Stripping." *Home Energy Guide.* Clemson, S.C.: Clemson University, 1977.

8. Eaton, William W. *Solar Energy.* Washington, D.C.: Energy Research and Development Administration, Office of Public Affairs, 1976.

9. Gross, Leonard. "Is More Less?" *Newsweek.* New York: Newsweek, July 14, 1975.

10. Federal Energy Administration. "Energy Conservation: Understanding and Activities for Young People." Washington, D.C.: Department of Energy, 1975.

11. Federal Energy Administration. *Energy Reporter.* Washington, D.C., 1977.

12. Harrison, Henry S. *Houses.* Chicago: Realtor's National Marketing Institute, 1973.

13. J.C. Penny. *Forum: People, Progress, and Priorities.* New York: J.C. Penny Co., 1976.

14. Lovins. *Soft Energy Paths: Toward a Durable Peace.* Cambridge, Mass.: Ballinger Publishing Co., 1977.

15. Midwest Plan Service. *Family Housing Handbook.* Ames, Iowa: Iowa State University, 1971.

16. National Association of Home Builders. *Designing, Building, and Selling Energy Conserving Homes.* Washington, D.C., 1978.

17. National Geographic. "Fewer Imports, More Conservation, Innovative New Sources." *Energy: A National Geographic Special Report.* Washington, D.C.: National Geographic Society, 1981.

18. Sherwood, R. F. *Homes Today and Tomorrow.* Peoria, Illinois: Charles A. Bennett Co., 1972.

19. Smith, Stephen M. *Energy Environment Mini Unit Guide.* Washington, D.C.: National Science Teachers Association, 1975.

20. Smith, Stephen M. *Energy Environment Source Book Guide.* Washington, D.C.: National Science Teachers Association, 1975.

21. South Carolina Department of Education, *Housing and Home Furnishings Curriculum Guide, Module 58.* Columbia, S.C., 1981.

22. South Carolina Electric and Gas. "Residential Electrical Service Charges."

23. South Carolina Governor's Office, Division of Energy Resources. *S.C. Passive Solar Home Design: Low Cost Energy Efficient Opportunities.* Columbia, S.C., 1980.

24. Standard Oil Co., Indiana. "It's A Great System, Pass It On." Chicago: Standard Oil Co.

25. United States Department of Energy. *Energy Conservation in the Home: An Energy Education Conservation Curriculum Guide for Home Economics Teachers.* Oak Ridge, Tennessee: Technical Information Center, 1977.

26. United States Department of Energy. *Tips for Energy Sources.* Oak Ridge, Tennessee: Technical Information Center.

27. United States Department of Housing and Urban Development, Office of Policy Development and Research. "Climate, Comfort, and Your Building. *"Regional Guidelines for Building Passive Energy Conserving Homes.* Washington, D.C.: Supt. of Documents, U.S. Government Printing Office.

Ordering Information

1. "Tips and Topics in Home Economics" Vol. XX1, No. 4 Summer 1981
College of Home Economics
Texas Tech University
P.O. Box 4170
Lubbock, Texas 70409

2. *Forum: People Progress, and Priorities,* Fall/Winter 1976
J.C. Penny Co., Inc.
Educational Relations Department
1301 Avenue of the Americas
New York, NY 10019

3. *Energy Environment Mini Unit*
Energy Environment Source Book
National Science Teachers Association
1742 Connecticut Avenue N.W.
Washington, D.C.

4. *Energy Conservation in the Home: An Energy Education Conservation Curriculum Guide for Home Economics Teachers*
U.S. Department of Energy
Technical Information Center
P.O. Box 62
Oak Ridge, Tennessee 37830

Annotated Media Listing

1. ''Bridging the Gap''. 16 mm., 23 min., middle and high school. Good overview of how technology is being used to find energy sources which can be used to bridge the gap for energy needs until the time that more advanced sources are economically feasible. The emphasis placed on the film publisher's (Conoco) role in this search needs to be put into perspective but does not distract from the information imparted through the film. FREE LOAN.

   Available from: Conoco Inc.
   Public Relations Department
   High Ridge Park
   Stamford, Conn. 06904
   (203) 329-2300, et. 3479

2. ''Coal to Kilowatts'', 16 mm., 9 min., middle and high school. Good look at using coal as a source for producing electrical energy. Study guide included. FREE LOAN.

   Available from: Carolina Power and Light Company
   411 Fayetteville St. Mall
   14C3 Center Plaza Building
   Raliegh, N. C. 27602

3. ''Endless Chain'', 16 mm., 28 min., middle and high school. This film shows the life-death cycle as energy passes from plant to animals. FREE LOAN.

   Available from: Department of Energy Film Library
   Technical Information Center
   P. O. Box 62
   Oak Ridge, Tenn. 37830.

4. ''Energy and Everyday Life'', filmstrip/cassette/instructional kit. Middle school regular classroom or high school MR students. Good material addressing two topics, ''Energy from the Sun'' and ''Energy from the Earth''. Each kit contains 3 filmstrips, accompanying audio cassettes, a set of booklets for students' use, and xerox/duplicating masters of games, quizes, puzzles. Produced by National Geographics Society. FREE LOAN.

   Available from: Carolina Power and Light Company
   411 Fayetteville St. Mall
   14C3 Center Plaza Building
   Raleigh, N. C. 27602

5. ''Energy for the Future'', 16 mm., 17 min., middle and high school. Excellent source for content material relative to future energy sources. Well worth RENTAL FEE $16.00.

   Available from: Encyclopedia Britannica, Educational Corp.
   425 N. Michigan Avenue
   Chicago, Ill. 60611
   (312) 321-6800

6. ''Energy Sources of the Future'', 16mm., 15 min., color, Good unbiased presentation of the search for energy alternatives. RENTAL FEE $22.00

Available from: McGraw-Hill Film
Modern Talking Picture Service, Inc.
500 Park Street North
St. Petersburg, Fla. 33709

7. ''Energy: The American Experience'', color, 16 mm., 2[illegible] min., 1978. The viewer sees the 60 year changing cycles of energy sources, from wood to coal to oil and gas, which produce the steam and electrical energy that helped make the United States the industrial giant of the world. Current work on energy sources such as solar, geothermal, and wind power are shown. FREE LOAN.

Available from: Department of Energy Film Libr.
Technical Information Center
P. O. Box 62
OakRidge, Tenn. 37830

8. ''Energy: The Ultimate Problem?'', 16 mm., 10 min., middle and high school. Good conscience raising film depicating energy use which exceeds energy resources. Alternative energy sources are reviewed. Purchase price $185.00. Preview available.

Available from: Coronet Instructional Media
65 East South Water Street
Chicago, Ill., 60601
(312) 977-4000.

9. ''Energy: What About Tomorrow?'' 16 mm., color, 20½ min., grade level 7-12. Fair presentation of alternate energy sources being researched for the next century. Teacher needs to summarize the major alternatives for clarity. RENTAL FEE $29.50; Preview available.

Available from: Barr Films
P. O. Box 5667
Pasadena, Calif. 91107

10. ''From Rubbish to Riches'', 16 mm., 11 min., middle and high school. Good description of some of the ways waste products can be converted into fuel and trash can be recycled into usable products. Study guide included. FREE LOAN.

Available from: Carolina Power and Light Company
411 Fayetteville St. Mall
14C3 Center Plaza Building
Raleigh, N. C. 27602

11. ''Fuel of the Future'', slides/cassette, 12 min., high school and adult. Fair presentation describing coal liquefaction and giving a general overview of alternative energy sources being developed. PR aspects for Ashland Oil are evident but do not interfer with information. FREE LOAN.

Available from: Ashland Oil, Inc.
Community Relations Representative
P. O. Box 391
Ashland, KY 41101
(606) 329-4363

12. ''Home Heating System'', 16 mm., color, 12 min., offers a good brief review of the fundamentals of heat transfer. FREE LOAN.

Available from: Communications Center
Room 92, Plant and Animal Science Building
Clemson University
Clemson, S. C. 29631

13. ''Nature, Man, and Architecture'', filmstrip, 50 frames. Focuses on the use of architectual design in primitive and modern societies to solve human problems. RENTAL FEE less than $5.00.

Available from: Director of Public Information Services
The American Institute of Architects
1735 New York Avenue, N. W.
Washington, D. C.

14. ''New Answers to an Old Problem'', slides/cassette, 15 min., high school and adult. Fair presentation focusing on coal liquefaction and the production of gasohol using coal as its manufacturing energy source. This presentation would be useful in broadening the topic of future energy sources. PR aspects for Ashland Oil which are evident at times do not distract from the presentation as an informative source. FREE LOAN.

Available from: Ashland Oil, Inc.
Community Relations Representative
P. O. Box 391
Ashland, KY 41101
(606) 329-4363

15. ''Project Sage'', 16 mm., 18½ min., middle and high school. Good presentation describing an active solar heating system built on a housing project in California. FREE LOAN.

Available from: Department of Energy Film Library
Technical Information Center
P. O. Box 62
Oak Ridge, Tenn. 37830

16. ''Putting the Sun to Work'', 16 mm., 5 min., middle and high school. Fair but technical explanation of some models of solar collectors. Film is useful to acquaint student with techniques which may be possible in the future. FREE LOAN.

Available from: Department of Energy Film Library
Technical Information Center
P. O. Box 62
Oak Ridge, Tenn. 37830

17. ''Solar Energy: The Great Adventure'' 16 mm., color, 28 min. Good overview of solar energy projects presently being used in the United States. Narrated by Eddie Albert. FREE LOAN.

Available from: Department of Energy Film Library
Technical Information Center
Box 62
Oak Ridge, Tennessee 37830

18. ''Solar Horizon'', 16 mm. 28 min. Good film to use when only one film can be shown concerning solar energy. It depicts the passive and active use of solar energy as well as creative uses of solar energy under research for future use. FREE LOAN.

Available from: Corporate Communications Department
Carolina Power and Light Company
411 Fayetteville St. Mall
14C3 Center Plaza Building
Raleigh, N. C. 27602

19. ''Sunbuilders'', 16 mm., color 20 min. Excellent depiction of passive solar energy use. Specific measures to take to implement passive use of solar energy reinforce and summarize content of this curriculum. FREE LOAN.

Available from: Department of Energy Film Library
Technical Information Center
P. O. Box 62
Oak Ridge, Tennessee 37830

20. ''The Energy Experience'', 16 mm., 20 min,, color. Good discussion of how fuel sources of the past evolved, indicating they are running out. New energy sources are being researched to provide energy the earth will need. A pleasant unexpected feature in the film is a beautiful time laspe photo series of plant growth. FREE LOAN.

Available from: Audience Planners Inc.
1 Rockefeller Plaza
New York, NY 10020

21. ''The Future'' (from the Universe and I Series), 16 mm., 17 min., middle and high school. Good presentation of what life maybe like in the future including a look at transportation, homes, energy sources. Interesting, thought provoking film. RENTAL FEE $30.00.

Available from: Agency for Instructional Television
1111 West 17 Street
Bloomington, Ind. 47401

22. ''Turning Point'' 16 mm., 24 min., color, Fair description of fossil fuels development and use. Alternate methods of supplying energy in the future are reviewed, focusing mainly on the use of natural gas as an energy source. FREE LOAN.

Available from: Trans Canada Pipelines
Public Affairs Department
P. O. Box 54
Commerce Court West
Toronto, Canada M5L 1B9

EVALUATION

ENERGY EDUCATION CURRICULUM GUIDE

YOUR VIEWS ARE IMPORTANT! After you review and use this publication, please respond to the questions below and forward your comments to the Home Economics Education Unit, Program Planning and Development, Office of Vocational Education, 918 Rutledge Building, Columbia, SC 29201. Please respond so that your views can be considered as we plan future publications.

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_____ Completely
_____ More than half
_____ Less that half
_____ Just read the material

Does this publication fulfill its purpose as stated in the preface or introduction?

_____ Completely
_____ Partly
_____ Not at all

Did you find this publication useful as a classroom resource?

_____ Very useful
_____ Average
_____ Fairly useful
_____ Not useful

Which section is most valuable?_____

_____

In which courses have you incorporated this material?

_____ Basic C&H
_____ Advanced C&H
_____ Consumer Education
_____ Child Development
_____ Family Life Education
_____ Education for Parenthood
_____ Clothing & Textiles
_____ Housing and Home Furnishings
_____ Human Sexuality
_____ Foods & Nutrition
_____ Other _____

Did you find the content to be stated clearly and accurately?

_____ Always yes
_____ In general, yes
_____ In general, no
_____ Always no
_____ Other _____

Were the contents presented in a convenient format?

_____ Very easy to use
_____ Fairly easy
_____ Fairly difficult
_____ Very difficult
_____ Other _____

Did you find this publication to be free of discrimination or biased content towards racial, ethnic, cultural and religious groups, or in terms of sex stereotyping?

_____ Yes, without reservations
_____ Yes, with reservations
_____ No
_____ Other _____

What is your impression of the overall value of the publication?

_____ Excellent _____ Fair
_____ Good _____ Poor

Would you recommend this publication to a colleague?

_____ Yes, without reservations
_____ Yes, with reservations
_____ No

When this publication is revised, what changes would you like to see made?_____

_____

_____

Additional comments. (Attach a sheet if you wish.) _____

_____

_____

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